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THE STATUS OF THE NATION'S HIGHWAYS AND BRIDGES: CONDITIONS AND PERFORMANCE

AND

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM 1989

REPORT

OF THE

SECRETARY OF TRANSPORTATION

TO THE

UNITED STATES CONGRESS

Pursuant to Sections 307(e) and 144(i) of Title 23, United States Code

JUNE 1989

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Committee on Public Works and Transportation
One Hundred First Congress
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Room 2165, Rayburn House Office Building
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June 8, 1989

Honorable Samuel K. Skinner
Secretary of Transportation
Department of Transportation
400 Seventh Street, S.W.
Washington, D. C. 20590

Dear Secretary Skinner:

This letter acknowledges receipt by the Committee on Public Works and Transportation of the tenth biennial report, "Status of the Nation's Highways and Bridges: Conditions and Performance", required by Section 307(e) and 144(i) of Title 23, United States Code.

The preceding biennial reports on the condition and performance of the nation's highway infrastructure have provided Congress with valuable analyses of the effectiveness of past national policies and the appropriateness of those policies to emerging national needs.

The 1989 report continues in that tradition by presenting three future investments strategies, summarized in Table I-1. The Committee is concerned that all three investment strategies may result in lower quality service on the most important segments of the nation's highway system. As the Congress begins an extensive review of the national surface transportation policies, the Committee believes the scope of this report should have provided the range of information that will be needed to adequately assess the nation's transportation needs.

The Committee is also concerned that the biennial report did not analyze other strategies that would preserve and improve mobility. It is conceivable, indeed probable, that a higher level of capital expenditure could improve the safety and efficiency of highway travel, avoid the social, environmental and economic costs of a declining system and do so at a lower cost to society than any of the options presented in this report.

Congress must, of course, search for those more effective strategies. We urge the Department of Transportation to accelerate its efforts to examine the costs, benefits and national economic implications associated with a broad array of investment options. This would greatly assist Congress in its efforts.

The value of future reports in this biennial series would be enhanced by:

o Providing a measure of unit and aggregate user costs associated with each investment strategy.

o Providing an investment scenario for the preservation of current conditions and service utilizing a full array of improvement options.

o Incorporating operational and other non-construction options within all strategies studied.

o Providing a means to relate the condition and service measures used in different years when such measures are changed.

o Improving the methodology of measuring congestion effects on high volume urban sections.

Sincerely,

GLENN M. ANDERSON
Chairman

THE DEPUTY SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

January 26, 1989

The Honorable Jim Wright
Speaker of the House
of Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

This letter transmits for your consideration the biennial report, "Status of the Nation's Highways and Bridges: Conditions and Performance," required by Sections 307(e) and 144(i) of Title 23, United States Code. Part I of the report describes recent activities in highway finance, systems condition and performance, and future capital investment requirements. Part II describes the implementation of the Highway Bridge Replacement and Rehabilitation Program.

With warmest regard,

Sincerely,

Mimi Weyforth Dawson

Enclosure

THE STATUS OF THE NATION'S HIGHWAYS AND BRIDGES: CONDITIONS AND PERFORMANCE

AND

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM

1989

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PART I

THE STATUS OF THE NATION'S HIGHWAYS AND BRIDGES: CONDITIONS AND PERFORMANCE

1989

CHAPTER I

INTRODUCTION AND SUMMARY

Purpose

This is the tenth in a series of biennial reports submitted to Congress pursuant to Section 307 of Title 23, United States Code. The purpose of the report is to provide Congress with an assessment of the present conditions and future investment requirements for the Nation's highways and bridges.

The report describes selected aspects of our major highway and bridge networks in terms of trends related to finance, physical and operating characteristics, and future funding levels required to satisfy a range of performance goals. These data are compared to information from prior years, particularly as found in the 1987 report. The report also contains projections of investment-performance relationships through the end of 2005 and a discussion of issues specifically related to the Federal-aid highway program. The time horizon for this report is three years longer than the 1987 report, from 1987-2005 as compared to 1985-2000 for the 1987 report. Because of the increased time span included in this report, overall investment requirements are greater than in the 1987 report. In addition, because the design life of simulated investments are incorporated within the simulation procedures used for this report, the instance of second generation improvements is greater in this report, thereby increasing the annual investment requirements.

The information contained within provides an aggregate picture of how the Nation's highway investment has been used to achieve the goals set for the program, and what revenue levels will be needed in the future to meet the demands of social and economic growth.

In addition, Part II of this report contains the report to Congress on the Highway Bridge Replacement and Rehabilitation Program (HBRRP) and the status of the National Bridge Inventory (NBI). This report is required by Section 144(i) of Title 23, U.S. Code. The report details the progress made in administering the HBRRP through June 30, 1988, the status of bridge inventories for both Federal-aid and off-system bridges, and the status of bridge management systems.

Scope

The report views highway issues primarily from a national, or aggregate, perspective, although Chapter III, Highway Conditions and Performance, demonstrates that there is a wide variance in highway conditions among individual States. The Federal role, as defined by Congress, does not include local road mileage. Therefore, this report does not include detailed information pertaining to this segment of the Nation's surface transportation network. However, the secondary impact of Federal financing decisions on local jurisdictions is minimally addressed in Chapter II.

The report concentrates on major highways and urban streets, including all arterials and collectors. Although only 30 percent of the Nation's mileage is covered by the report, these major functional systems carry 87 percent of all highway vehicle mile of travel.

The report also includes separate information on bridges because of the increasing importance of bridges as a national priority.

Information Sources

The Federal Highway Administration (FHWA) and the States have jointly developed and implemented a data system called the Highway Performance Monitoring System (HPMS) which supplies timely information about the condition and use of the major highway systems and about the capital investment being made to improve these systems. The HPMS is the primary source of information contained in this report. It supplies a continuous picture of how and where highway conditions are changing and how investment levels and patterns are related to the changes. The HPMS is a sample based system that relies on annual State data submittals to reflect changes in the physical and operating characteristics and, ultimately, the future investment requirements for the Nation's highway systems. Because of the statistical imprecision inherent in any sample based data collection system, the relative changes in conditions over time should be considered more reliable than the absolute value of any condition. Chapters III and IV describe in more detail the nature and use of the HPMS systems.

The chapter on finance is based on material from the FHWA-534 Report, Highway Capital Outlay and Maintenance Expenditures. This reporting system was developed in conjunction with the HPMS to identify relationships between system condition and performance and expenditures on any highway functionally classified as a nonlocal road.

The data used for the estimation of bridge investment requirements in Chapter IV are derived from the National Bridge Inventory, a complete inventory of physical and operating conditions on all Federal-aid and non-Federal-aid system bridges.

Highway Systems

Throughout this report references are made to functional and Federal-aid systems. All roads are classified functionally. A subset of all roads are designated as Federal-aid systems, eligible for Federal funding. The various systems are defined as follows:

Functional Systems

- Principal Arterial System - in rural areas, a network of routes that primarily serves travel of statewide or interstate significance; that serves virtually all urban areas over 50,000 population; that provides high overall travel speeds with minimum interference to through activity; that serves the high traffic volume corridors and the longest trip lengths; and that carries a high proportion of area travel.

  The principal arterial system is stratified as follows: (a) Interstate; (b) other freeways and expressways (in urban areas only); and (c) other principal arterials.

- Minor Arterial System - in rural areas, a network of routes that provides access to principal arterial routes and, in conjunction with principal arterials, that links cities and larger towns to facilitate interstate and intercounty service. In urban areas, this system serves trips of moderate length at a somewhat lower level of travel mobility. Such routes interconnect with and augment the principal arterial system. They may carry local bus routes and provide intracommunity connectivity.

- Collector System - in rural areas, a network of routes that generally serves travel of a localized nature and on which predominant travel distances are shorter than on arterial routes. The rural collector system is stratified as follows: (a) major collectors--serving county seats and other traffic generators not directly served by arterial routes, and (b) minor collectors--linking locally important traffic generators with small communities. In urban areas, such routes distribute trips to and from the arterials and provide for local traffic movement within residential neighborhoods, commercial areas, and industrial areas.

Federal-Aid Systems

- The National System of Interstate and Defense Highways consists of routes of highest importance to the Nation that:
  - connect, as directly as possible, principal metropolitan areas, cities, and industrial centers, including important routes into, through, and around urban areas;
  - serve the national defense and,
  - connect at suitable border points with routes of continental importance in Canada and Mexico.

  The Interstate System is a subsystem of the primary system.

- The Federal-Aid Primary System consists of interconnecting main roads important to interstate, statewide, and regional travel, consisting of rural arterial routes and their extensions into or through urban areas.

- The Federal-Aid Secondary System consists of rural major collector routes.

- The Federal-Aid Urban System consists of urban arterial and collector routes exclusive of urban extensions of the Federal-aid primary system.

Highway Finance Trends

Highway finance is a highly complex system that includes extensive revenue transfers among thousands of individual jurisdictions and levels of government. Federal, State, and local governments use a variety of revenue raising mechanisms to finance a wide range of highway activities, including administration, operation and maintenance, and capital improvements. Changes in highway finance is one of the factors that directly affect the performance of the highway system.

Highway receipts generated by all units of government in 1987 exceeded $66 billion. (All time references in the Finance Section refer to calendar years.) Federal collections for highways in 1987 totaled $14.5 billion, as has been roughly the case since 1982. States collected $32.8 billion in 1987, while counties and muncipalities collected $19 billion.

The Federal share of national highway revenue receipts has been decreasing since 1985 and in 1987 reached the lowest mark in 27 years (22 percent). State highway revenues comprised about 49 percent of all highway funds in 1987, a level which has not changed significantly in the last 10 years. County and municipal revenues (local) comprised a larger share (29 percent) of total highway collections in 1987 than they ever had in the past. Ten years ago local receipts accounted for 22 percent of total highway collections by all units of government.

In 1987, taxes and fees (imposts) on users accounted for roughly 85 percent of total revenue collected (excluding bond proceeds) at the combined Federal and State levels. At the State level there is a continued dependence on revenues from nonuser or general sources to satisfy highway finance needs. The nonuser share of State finance has grown nearly three-fold during the last 20 years.

Outlays for capital improvements as a percent of total disbursements has remained relatively constant since 1984 at about 47 percent. From the beginning of 1986 to the end of 1987 capital outlays increased only 6 percent. There has been a shift between urban and rural disbursements. Since 1982, urban areas have been receiving an increasing share of highway outlays, consistant with the increase in urban mileage through new highway construction and annexation of rural areas.

Federal and State capital funding for all types of highway improvements has increased over the past two years. The greatest changes occurred in the categories of rural new construction, major widening and safety, each of which increased by about 25 percent. Rural new construction increased by $850 million, major widening by $188 million and safety by $122 million. In urban areas, new construction funding increased $1.9 billion, from almost $4 billion to almost $5.9 billion, raising urban new construction expenditures from 29 to 35 percent of total highway capital expenditures. Urban new construction has accounted for the largest single type of expenditure among all highway capital improvement categories since 1985.

Highway Conditions and Performance

Total highway travel in 1987 reached 1.92 trillion vehicle miles of travel (VMT), an increase of 8.4 percent over 1985. Urban travel increased by 9.4 percent during the period and now represents 59.4 percent of total travel. Although urban mileage increased over the same period as a result of new construction and reclassification from rural to urban through annexation, the increased mileage was barely sufficient to maintain overall density of travel per lane-mile in urban areas.

Highway travel grew at an annual rate of almost 4.9 percent in 1987, and at 3.4 percent in 1986. Since 1966, the average annual rate of growth in highway travel has averaged 3.5 percent. Except for the periods 1973-1974 and 1979-1982, the years of the petroleum shortage and the recession of the early 1980's, travel growth has exceeded 3.5 percent in each year since 1966. From mid-1985 to mid-1987, highway travel growth has been most pronounced in New England (12.2 percent) and the Northern Southeast region (11.8 percent). The smallest increases in travel, all in the 5 percent range, have occurred in the Rocky Mountain and Pacific regions.

As a result of this substantial growth in travel, the major highway systems in both rural and urban areas have experienced increasing congestion. The percent of peak hour travel on urban Interstates that occurred under congested conditions reached 65 percent in 1987, up from 61 percent in 1985, and 54 percent in 1983.

In 1987, there were 3.87 million miles of streets and highways in the Nation. Over 81 percent of this mileage was in rural areas, but rural mileage has decreased by 7000 miles since 1985 largely due to the continued redefinition of certain areas from rural to urban and the reclassification of certain U.S. Forest Service roads to nonpublic roadways.

Between mid-1985 and mid-1987, the percentage of pavements in poor condition, that is, currently in need of capital improvements, decreased on the arterial and collector systems, increased slightly on rural Interstates, and remained stable on urban Interstates. The percentage of pavements in very good to excellent condition decreased on all systems except the rural collector system. From mid-1985 to mid-1987, pavements rated in this category on the rural Interstate System declined from 33.8 percent to 29.9 percent and, on the urban Interstate System, from 35.3 percent to 29.4 percent. Other arterial highways showed a similar, but slightly less significant, reduction in pavement rated very good or excellent.

Bridge conditions generally deteriorated over the 2-year period from mid-1986 to mid-1988 compared to mid-1984 to mid-1986. The proportion of Interstate bridges classified as deficient rose from 10.6 percent in 1982 to 13.1 percent in 1984, to 14.3 percent in 1986 and to 15.9 percent in 1988.

The physical and operating conditions of streets and highways are among the factors that affect highway safety (in addition to the social and regulatory factors). For the most recent period, mid-1986 to mid-1987, the fatality rates dropped on four of the functional systems (urban interstate, urban and rural arterial and rural and urban collectors) while remaining fairly stable on the remaining systems. In 1986, these rates ranged from a low of 0.87 fatalities per 100 million VMT on the urban Interstate System to a high of 4.03 fatalities per 100 million VMT on the rural collector systems.

Changes in pavement and bridge conditions, congestion levels, and highway geometrics affect the costs involved in using the Nation's roads and streets. These highway user costs, both private and commercial, eventually affect the national economy, through transportation costs for goods and services. From mid-1985 to mid-1987, the total unit cost of travel decreased by an estimated 1 percent. During this period, the total unit cost declined from $623.61 per 1,000 VMT to $617.32 per 1,000 VMT (as measured in 1985 dollars). Unit travel costs declined on each functional class except urban minor arterials, which increased slightly.

Highway and Bridge Investment Requirements

Highway investment requirements are a function of current conditions and future travel demand. Travel is expected to increase through the year 2005 by between 2.0 percent and 3.0 percent annually. Although this range of forecasted rates is lower than the actual current rate of growth, demographic changes, combined with the "saturation effect" of the Nation's vehicle fleet is expected to dampen future growth in highway travel. Bridge investment requirements are relatively independent of travel growth.

Full constrained needs through 2005 on the existing highway and bridge systems range from $34.7 to $39.4 billion annually in 1987 dollars. At these investment levels, overall conditions on the highway system may be expected to improve, although in some of the larger urbanized areas congestion may worsen. Full constrained needs does not imply system perfection. It means that, no highway segment will exhibit physical or opeating characteristics below those considered minimal by a consensus of engineering judgment, at any time throughout the analysis period, in this case, through 2005. The minimum conditions are considered the least tolerable conditions that would allow highway authorities to safeguard public safety on the highway system and provide the most cost-effective, long-term solution to capital needs.

The full constrained estimates do not simulate any capacity additions where the States have indicated that such additions are currently considered infeasible because of the costs of rights-of-way. Traditional highway capacity improvements cannot feasibly be made on many existing facilties, particularly in larger urbanized areas, to accommodate the expected growth in travel, even at the low travel forecast. Either additional higher cost capacity must be added, or some combination of capacity addition, traffic management improvements, and travel behavior modification must be considered, in order to deal with existing and anticipated problems of urban congestion. The larger urbanized areas cannot rely exclusively on traditional highway construction as a solution to the existing and projected problem of peak-period congestion. It is for this reason that congestion may be expected to worsen in the larger urbanized areas under this investment scenario.

The average annual cost to maintain overall 1985 conditions on highways and meet backlog and accruing bridge needs will range from $25.1 to $28.8 billion through 2005. At these levels of investment overall highway conditions can be expected to remain essentially unchanged, except on both the rural and the urban portions of the Interstate System. For the first time since this report has been prepared, current overall conditions on the Interstate System cannot be maintained without capacity additions beyond what is considered feasible by today's standards. The cost-to-maintain overall conditions estimate, therefore, does not include the addition of between 11,000 and 15,000 lane-miles, or their equivalent, of new capacity on the urban and rural Interstate System necessary to fully maintain an overall composite rating of condition and performance. These lane-miles are currently considered infeasible to build because of right-of-way restrictions. Because of the extraordinary nature of these additional lane-miles, costs are not included for them under the cost to maintain overall conditions. For this reason, the cost to maintain overall conditions estimate maybe understated, perhaps substantially, depending on the nature (and costs) of improvements that might be selected to mitigate the existing and projected congestion problems.

The 11,000 to 15,000 lane-mile shortfall is a measure of scale, and should not be interpreted as the sole means of satisfying future travel demand. Options to address this shortfall might include systems management improvements, peak-hour demand management, transit, new construction, and other options to either enhance the operation of the existing system, reduce, or spread demand to off-peak hours.

The cost-to-maintain systems performance estimates reflect investment requirements to maintain overall conditions on the lower functional systems and to maintain current levels of service on the higher systems. This level of investment, from $25.1 to $28.7 annually, would keep each functional system doing what it was designed to do, as well as it did it in 1985, to the extent that it can be done within the confines of available rights-of-way. This level of investment does not include the addition of between 11,250 and 25,000 lane-miles, or their equivalent, of new capacity on the urban and rural Interstate System, and other urban freeways and principal arterials, for the same reasons included in the preceding paragraph. The essential difference between these last two investment levels is in the number of additional lane-miles that would be required to achieve the stated objective, either maintenance of overall condition or maintenance of overall system

performance. Actual cost-to-maintain systems performance through the use of new construction would place greater emphasis on urban investment, and more on higher functional systems. As in the preceding paragraph, however, new construction is only one of several options available for addressing the shortfall.

Bridge estimates in this report were derived using a newly developed investment/performance analytical procedure similar to that used for highway analysis. This procedure considers accruing investment requirements as well as backlog requirements, a capability not available prior to this report. A detailed description of the procedure and general discussions of functional and Federal-aid systems bridge requirements using the procedure are included in Chapters IV, V, and in Part I, Appendix B. This procedure supercedes and will replace the sufficiency rating procedure used to calculate bridge requirements for previous reports. For purposes of clarification, a comparison of the new and old procedures are included, as necessary, throughout the appropriate sections of the report. For those readers interested exclusively in the annual bridge program status, Part II contains the Highway Bridge Replacement and Rehabilitation Program Report for 1989.

Backlog and accruing bridge needs through 2005 are approximately $93 billion for all bridges, or $4.9 billion on an average annual basis. For the Federal-aid system, bridge needs are approximately $72 billion, or almost $3.8 billion annually. Backlog bridge deficiencies account for approximately two-thirds of overall bridge investment requirements, a much higher percentage than the comparable backlog estimate for highways. Because of the potentially greater risk to public safety of bridge failure as compared to highway failure, the annualization of bridge investment requirements should be considered only for overall policy purposes. Annualized estimates should not be used for program development purposes without a careful examination of the potential consequences for bridge performance and public safety.

Tables I-1, 2, and 3 summarize investment requirements by functional and Federal-aid system, including bridge requirements.

TABLE I-1

Capital Investment Requirements by all Units of Government
for the Existing Highway and Bridge Systems, 1987-2005

(Billions of 1987 Dollars)

Functional System	Cost to Maintain 1985 Overall Conditions (see note "a")		Cost to Maintain 1985 System Performance (see note "b")		Constrained (c) Full Needs	
VMT Growth Rate (%)	2.0	3.0	2.0	3.0	2.0	3.0
RURAL						
Interstate	34.8 (a)	42.5 (a)	34.8 (b)	42.5 (b)	34.8	42.5
Other Principal Arterials	18.8	23.6	18.8	22.8	42.5	51.5
Minor Arterials	20.5	22.9	20.5	22.9	48.3	53.9
Major Collectors	33.2	34.6	33.2	34.6	86.1	90.1
Minor Collectors	15.1	16.1	15.1	16.1	51.0	54.5
Subtotal	$122.4	$139.7	$123.4	$138.9	$262.7	$292.5
URBAN						
Interstate	53.8 (a)	73.8 (a)	53.8 (b)	73.8 (b)	53.8	73.8
Other Freeways & Expwy	28.0	34.1	28.0 (b)	33.8 (b)	28.0	33.8
Other Principal Arterials	90.1	103.6	90.1 (b)	103.5 (b)	89.9	103.6
Minor Arterials	60.7	71.3	60.7	71.3	82.1	97.2
Collectors	28.1	31.4	28.1	31.4	49.0	54.7
Subtotal	$260.7	$314.2	$260.7	$313.8	$302.8	$363.1
Total Highway	$383.1 (a)	$453.9 (a)	$383.1 (b)	$452.7 (b)	$565.5	$655.6
(average annual)	20.2	23.9	20.2	23.8	29.8	34.5
Total Bridge (d)	$92.9	$92.9	$92.9	$92.9	$92.9	$92.9
(average annual)	4.9	4.9	4.9	4.9	4.9	4.9
Total Highway & Bridge	$476.0 (a)	$546.8 (a)	$476.0 (b)	$545.6 (b)	$658.4	$748.5
(average annual)	$25.1 (a)	$28.8 (a)	$25.1 (b)	$28.7 (b)	$34.7	$39.4

(a) At this level of investment, overall conditions cannot be maintained on the Interstate System within existing rights-of-way. A shortfall of between 11,000 and 15,000 lane-miles of new capacity, or their equivalent, would be the result. Options to address this shortfall include new construction, systems operation improvements, toll facilities, peak-hour demand management, and transit. See Chapter IV for details.

(b) At this level of investment, system performance cannot be maintained on either the urban or rural portion of the Interstate System, the urban freeways and expressways, and the urban principal arterials, within existing rights-of-way. A shortfall of between 11,250 and 25,000 lane-miles of new capacity, or their equivalent, would be the result of these investment levels. Options to address this shortfall include new construction, systems operation improvements, toll facilities, peak-hour demand management, and transit. See Chapter IV for details.

(c) This investment strategy assumes that capacity improvements will be made only where rights-of-way are currently available. This would result in system performance improvements on the lower functional systems, but performance deterioration on the higher systems, especially in highly congested urbanized areas where rights-of-way are at a premium.

(d) Bridge needs are based on a 2.34% average annual growth in travel. These estimates could change under alternative travel scenarios or investment strategies. The investment levels under each scenario represent the full cost of eliminating all backlog and accruing deficiencies.

TABLE I-2

Estimated 1987-2005 Capital Requirements on Federal-Aid Systems by all Units of Government to Maintain Overall 1985 Conditions (in billions of 1987 dollars)

Category	VMT Growth Rate 2.0%	3.0%
Interstate Completion	16.3 (a)	16.3 (a)
Interstate 4R	88.6 (b)	116.4 (b)
(average annual)	4.7	6.1
Primary	108.3	127.4
(average annual)	5.7	6.7
Secondary	30.4	31.7
(average annual)	1.6	1.7
Urban	121.3	140.3
(average annual)	6.4	7.4
Subtotal	$364.9	$432.1
(average annual)	$18.3 (c)	$21.9 (c)
Bridge		
Interstate	24.6	24.6
Primary	26.8	26.8
Secondary	7.5	7.5
Urban	13.1	13.1
Off-system	21.0	21.0
Subtotal	$93.0	$93.0
(average annual)	$4.9	$4.9
Total Highway and Bridge	$457.9	$525.1
(average annual)	$23.2 (c)	$26.8 (c)

(a) cost to complete the Interstate System as of January 1, 1988

(b) At this level of investment, overall conditions cannot be maintained on the Interstate System within existing rights-of-way. A shortfall of between 11,000 and 15,000 lane-miles of new capacity, or their equivalent, would be the result. Options to address this shortfall include new construction, systems operation improvements, toll facilities peak-hour demand management, and transit. See Chapter IV for details.

(c) does not include cost to complete the Interstate System

TABLE I-3

Estimated 1987-2005 Capital Requirements on Federal-Aid Systems by all Units of Government to Maintain 1985 System Performance (in billions of 1987 dollars)

Category	VMT Growth Rate 2.0%	3.0%
Interstate Completion	16.3 (a)	16.3 (a)
Interstate 4R	88.6 (b)	116.4 (b)
(average annual)	4.7	6.1
Primary	108.3 (b)	126.4 (b)
(average annual)	5.7	6.7
Secondary	30.4	31.7
(average annual)	1.6	1.7
Urban	121.3 (b)	140.3 (b)
(average annual)	6.4	7.4
Subtotal	$364.9	$431.1
(average annual)	$18.3 (c)	$21.8 (c)
Bridge		
Interstate	24.6	24.6
Primary	26.8	26.8
Secondary	7.5	7.5
Urban	13.1	13.1
Off-system	21.0	21.0
Subtotal	$93.0	$93.0
(average annual)	$4.9	$4.9
Total Highway and Bridge	$457.9	$524.1
(average annual)	$23.2 (c)	$26.7 (c)

(a) cost to complete the Interstate System as of January 1, 1988

(b) At this level of investment, system performance cannot be maintained on either the urban or rural portion of the Interstate System, the urban freeways and expressways, and the urban principal arterials, within existing rights-of-way. A shortfall of between 11,250 and 25,000 lane-miles of new capacity, or their equivalent, would be the result of these investment levels. Options to address this shortfall include new construction, systems operation improvements, toll facilities, peak-hour demand management, and transit. See Chapter IV for details.

(c) does not include cost to complete the Interstate System

CHAPTER II
HIGHWAY FINANCE TRENDS

Summary

- Total dollars dedicated to highway purposes by all units of governments exceeded $66 billion in 1987. (The reader should note that all time frame references assume a calendar year.) Growth of the Bid Price Index (BPI), a measure of inflation in the highway construction industry, continued to slow, but did not reverse. The percent growth in revenue collections still out-paces the percent growth in the BPI, as has been true since 1983.

- In 1987, Federal collections for highways totaled $14.5 billion, as has been roughly the case since 1984. States collected $32.8 billion, while counties and municipalities collected $19 billion in 1987.

- In 1987, taxes on users accounted for roughly 85 percent of total revenue collected (excluding bond proceeds) at the combined Federal and State level. At the State level there is a continued dependence on nonuser (or general) revenues to satisfy highway finance needs. During the last 20 years (1967-1987), the nonuser share of State finance has grown nearly threefold (5 percent to 14 percent).

- Total disbursements increased, but at a declining rate from 1986 to 1987 relative to the previous period from 1984 to 1986. Disbursements increased 7 percent from 1986 to 1987 compared to a 11 percent average annual rate of increase from 1984 to 1986.

- Outlays for capital improvements as a percent of total disbursements has remained relatively constant since 1984 at about 47 percent of total disbursements. From 1986 to 1987 capital outlays increased 6 percent, from $29 billion to $31 billion.

- Since 1982, urban areas have been receiving an increasing share of highway capital outlays. For the first time a somewhat greater share of available funds was expended in urban areas as compared to rural areas (51 percent in 1986 and 53 percent in 1987).

- Federal revenues accounted for 22 percent of all highway revenues in 1987, the lowest Federal share in 27 years. State governments continue to account for about half of all revenues collected while the local government share reached 29 percent in 1987, the highest in 27 years. The local share has been higher than the Federal share since 1980 (except in 1984).

- During the two year period, 1986 through 1987, the level of Federal and State capital funds used for new construction, bridges, reconstruction, safety and major widening experienced notable changes from the previous 2 year period 1984 through 1985. Rural new construction, major widening and safety each increased by about 25 percent. For example, rural new construction increased from $3.5 billion to $4.3 billion, raising its share of total expenditures from 22 to 26 percent. In urban areas, new construction funding increased from, $4.0 billion to $5.9 billion, raising its share of total capital improvement expenditures from 29 to 35 percent. Urban disbursements for bridges increased 37 percent from $1.9 billion to $2.6 billion.

Introduction and Overview

This chapter presents a discussion of current highway finance, revenue collection and disbursement practices. A historical perspective is offered and trends are identified. The tables presented represent the net result of highway finance programing and policy decisions made at the Federal, State and local level.

Responsibility for supplying the Nation's highway infrastructure is assumed by governments, although there has been some privately financed road construction. While State, county, city and/or local governments own, operate and finance the vast majority of the national highway and road network, the Federal Government has a significant role in satisfying capital needs on certain highways of national importance.

The philosophy that highway systems should be user-supported has been evident since road-user taxes were levied in 1922. Federal and State governments have historically relied upon road-user charges such as motor fuel taxes to finance highway needs. The Federal-Aid Highway Act of 1956 and the accompanying Revenue Act established the Highway Trust Fund, which depends on revenues derived from Federal taxes levied on road users, and continued the pay-as-you-go principle to current financing practices.

The Federal-Aid Highway Program is a cooperative effort in which the Federal Government provides assistance to the States, both in planning and financing highway capital improvement programs on designated Federal-aid systems as well as certain broad based programs. The Federal-aid systems, while accounting for only one-fifth of all highway mileage, serve approximately 82 percent of all national travel. In 1987, the Federal-Aid Interstate System served 22 percent of all travel, the primary system 29 percent, the secondary system 9 percent and the urban system 22 percent.

The Federal Government collects highway user fees and redistributes the revenue to the States through intergovernmental transfers. State and local governments also collect revenues used for highways.

Deciding how to spend available revenues is a complex and difficult process that each State highway agency must undertake. The following section provides a general overview of State highway finance decisions leading to disbursements for highway improvements.

State Highway Program Development

State highway finance practices are determined by a programing process whereby funding allocation levels are determined and highway projects selected. The Federal Government requires that a program of Federal-aid projects be developed by each State and submitted to the FHWA for approval. Thus, a list of projects, as opposed to an individual project, is evaluated for eligibility of Federal funds. Federal-aid funds are paid directly to the State highway agencies.

The programing process varies from State to State. There are, however, fundamental components of the process that all State highway agencies generally incorporate either explicitly or implicitly.

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First, responsibility for highway and road segments on the functional systems is delineated along State or local lines. The State highway agency also decides which of the eligible functional system routes will be designated part of the Federal-aid highway system.

States then fund improvements on the existing system and system expansion. Further allocations are made in a somewhat sequential fashion: (1) among construction, preservation and improvement measures on the existing system; (2) among highway systems (i.e., Interstate, primary, etc.) and bridges; and (3) within work categories (i.e., surface improvements or drainage, geometric and capacity design).

Next, deficient highway sections and bridges are identified and compete for priority in the appropriate category. Project prioritization helps the State highway agency to decide which deficient highway sections or bridges should be improved immediately and which can be postponed. Some States also consider, on a project-by-project basis, the possibility of making only marginal improvements, thus reducing highway project costs and allowing more improvements to be undertaken.

Preliminary programs, based on technical analysis, are often constrained by policy considerations at the Federal, State and local level. Federal policy constraints include, among others:

- overall authorization levels;
- obligation ceilings;
- program authorization levels;
- limitations on transfers between program categories; and
- different matching ratios.

All States do some systemwide monitoring of existing conditions and performance. Current deficiencies are identified, improvements necessary to correct them determined, and cost estimates prepared. The cost requirements for the identified improvements are referred to as "current needs."

The States estimate future needs by projecting future traffic, applying deterioration factors, computing deficiencies, determining necessary corrective actions, and estimating the cost to correct the deficiencies. Future needs are often referred to as "evolving

needs." States consider themselves fortunate if current and projected funding levels are sufficient to correct evolving deficiencies.

Highway Revenues

In 1987, as indicated in Table II-1, over $66 billion was dedicated to highway purposes by governmental units. This marks the first time since 1973 that highway revenues remained relatively constant from one year to the next, with less than a 2 percent increase from 1986 to 1987. The previous 2-year trend, from 1984 to 1986, reflected an annual increase of approximately 9 percent.

Figure II-1 illustrates the relationship between revenues collected and the value of the construction dollar (as measured by the FHWA's BPI). Over the past 27 years, three periods, "1960-1973," "1974-1982," and "1983-current," with clearly defined trends may be identified.

The first period, 1960 through 1973, was influenced by an increasing number of drivers and growing per capita travel rates. Total dollars collected for highway purposes increased an average of 7 percent per year, or slightly ahead of the pace of inflation in the highway construction industry.

In the following period, 1974 through 1982, revenues lagged behind inflation and earlier gains in the buying power of the highway dollar were more than offset. The oil embargo of 1973 increased the price of petroleum and encouraged a more fuel-efficient motor vehicle fleet, reducing the volume of motor fuel sold. As a result, the rate of growth in total highway funds slowed. Highway officials no longer had the abundance of revenues they had become accustomed to during the prior 10-year period. In addition, the BPI began an extraordinary growth spurt in 1972 and by 1974 had outpaced the rate of increase in revenues collected. Revenues kept even with construction costs in 1976 and 1977 and then fell behind for the following 5 years. During this period, total highway revenue collections could not buy as much as they could at any time during the 1960's.

In 1982, revenues began to rise at an accelerated rate responding to tax increases imposed by the Surface Transportation Assistance Act of 1982 (STAA) and other State and local government actions. The BPI rate slowed and revenue collections once again

out-paced highway construction inflation. In 1984, the BPI resumed an upward climb, leveling off between 1985 and 1987. Revenues grew by an annual average of only 4 percent during the same 1985 to 1987 period but still exceeded highway construction inflation.

Revenue trends are presented in an alternative fashion in Figure II-2 where the growth of highway revenue is depicted by charting 4-year running averages since 1960. The highest levels of average annual growth during single 4 year periods occurred from 1965 through 1969, 1967 through 1971, and from 1982 through 1986, (reflecting the STAA of 1982). The average growth rate declined during the most recent 1983 through 1987 period.

Governmental Shares

In 1987, the Federal Government accounted for 22 percent of the total highway receipts collected by all units of government, or $14.5 billion. States collected slightly less than half of all proceeds, or $32.8 billion, while counties and municipalities provided the remaining 29 percent or $19 billion.

Federal receipts as indicated in Table II-1 rose from $10.1 billion in 1982 to $14.5 billion in 1987. State receipts increased from $22 billion to $33 billion during the same period, almost triple the increase in Federal revenue. The Federal share has been decreasing since 1985 and in 1987 reached the lowest mark in 27 years, or 22 percent.

The level of Federal highway contributions has hovered at between $14.5 and $15 billion since 1984. Revenues generated from imposts on highway users have increased slightly. However, Federal General Fund receipts have declined 37 percent since 1984. Road programs funded from general funds, substantially the General Revenue Sharing Program, have decreased by 44 percent or $366 million from 1984 to 1987, reflecting the philosophy that users pay for highway improvements.

State highway revenues, at $32.8 billion, comprised about 49 percent of all highway funds in 1987, a level which has not changed significantly in the last 10 years. The growth in State highway revenues from 1986 to 1987 was $450 million. Current revenues (that is, revenues excluding bond proceeds) increased 8.5 percent, or $2.4 billion, from 1986 through 1987. However, the level of bonds sold dropped $2 billion to $1.9 billion.

County and municipal revenues (local) comprised a larger share (29 percent) of total highway collections in 1987 than they ever had in the past. However, there has been only a moderate growth of 6 percent from 1986 through 1987, as compared to 16.5 percent annual growth from 1984 through 1986. Bond proceeds decreased 16 percent from $3 billion to $2.5 billion from 1986 to 1987.

Sources of Revenue

Federal and State governments have historically relied on road-user taxes for the bulk of their highway finance needs. Indeed, in 1987, highway user fees accounted for $40 billion out of $62 billion in revenue raised for all highways (excluding $4 billion in bond proceeds). In 1987, imposts on users accounted for roughly 85 percent of total highway revenue of combined Federal and State funds used for highways. Local governments derive a greater share of their funds used for highways from general (nonuser) revenues. Road user imposts accounted for only 8 percent of local highway revenues in 1987.

User fees represented 60 cents of the overall highway dollar for all units of government in 1987. The remainder was comprised of 26 cents in nonuser sources, 7 cents in bonds, and 7 cents in investment income and miscellaneous receipts. This level of user fees is lower than the peak in 1964 of 73 cents attributable to users, but moderately higher than the all-time low in 1982 of 55 cents. This trend is consistent with increased State and local participation in the overall highway program.

Excluding bond proceeds, there has been a long-term trend at the State level toward the increased use of general revenues for highways. At the State level, road-user charges contributed 95 percent of total receipts in 1965; by 1987 the user share was roughly 86 percent. The nonuser share of State finance for highways has grown nearly threefold during the last 20 years (5 percent to 14 percent).

At the local level there has been little change in the percent of highway receipts collected from various sources. Imposts on highway users which have historically provided less than 10 percent of local highway funds are beginning to increase and generated 8 percent of these funds in 1987 as compared to 5 percent in 1985. The share of income generated from investments, other receipts and combined general fund appropriations (or nonuser taxes) changed little over the past 5 years.

Intergovernmental Transfers

Significant amounts of Federal revenues, primarily from the Highway Trust Fund, are distributed as grants-in-aid to State and local governments. Similarly, States transferred 20 percent of their State-generated highway revenues to local governments in 1987. County and municipal governments transfer only minor amounts to other units of government. In 1987, net intergovernmental payments to the States were $6.8 billion, equivalent to 21 percent of total revenues ($33 billion) the States generated on their own for highway purposes. Total highway funds available to the States exceeded $39 billion in 1987.

Highway Disbursements

As shown in Table II-2, annual disbursements for highways (including local roads) have increased rapidly since the STAA was passed in 1982, reflecting increased revenue available from higher taxes. Since 1985, once the tax increases were fully implemented, the rate of increase slowed.

Capital expenditures, as indicated in Table II-3, continue to dominate total disbursements, accounting for roughly 47 percent of outlays. Capital outlays increased by 6 percent from 1986 to 1987. Other spending categories increased by less than 8 percent.

Federal-Aid Highway Expenditures

Federal-aid for designated highways is limited to capital expenditures such as construction and reconstruction and right-of-way acquisition. States and local government agencies have complete responsibility for maintenance (i.e., "pothole" repair, snow removal, grass cutting, etc.), daily operations and highway law enforcement. Federal participation in the Interstate has been substantial with 90 percent of capital improvements being eligible for pavement by the Federal Government. Other Federal-aid systems receive a 75-percent matching share, with bridges receiving about 80 percent.

However, because capital spending accounts for less than one-half of total spending for all highways, the Federal contribution to a total system is far less than the Federal-aid program share. For example, the capital costs of the Interstate System is funded on a 90-10 participation basis, but as indicated in the following table States contributed almost one-third of all funds (capital and operating) expended on Interstate highways in 1987:

PERCENT FEDERAL SHARE
INTERSTATE SYSTEM FUNDING
(1987)

	Share Capital & Operations	Share Capital Only
Rural	58	73
Small Urban	68	86
Urbanized	70	81
TOTAL	65	78

The non-Federal share includes (1) matching funds ("State Capital" above), (2) 100 percent State funded projects ("State Capital" above), and (3) maintenance and operations. The effective Federal share is far lower on the other Federal-aid systems.

State Highway Expenditures

As noted above, all noncapital costs and some of the capital costs are the responsibility of State and local governments. State capital expenditures reported to FHWA are summarized in Tables II-4 and II-5. In 1986, Federal participating programs (Federal allocation plus State matching funds) accounted for 74 percent of disbursements while in 1987 this dropped to 70 percent. This trend is directly counter to that of the previous 2 years reflecting increased State programs and constant Federal programs.

The most significant change in recent years has been the shift between urban and rural capital disbursements. In Table II-6, 1986 and 1987 disbursements are compared. Rural/urban disbursements were almost evenly split in 1986. In 1987 urban disbursements accounted for the largest share of funds expended, 53 percent. Since 1982, urban areas have received an increasing share of highway outlays (rising over 13 percentage points between 1982 and 1987).

As in past years, the majority of funds disbursed were for condition improvements and the remainder for right-of-way (ROW) and engineering. The percentage spent for ROW and engineering was stable at about 19 percent during the 2 year period, 1986 through 1987, an increase from a recent low of 17 percent in the two year period 1984 through 1985. In the two year period 1986 through 1987, 23 percent of urban disbursements were for ROW and engineering work and the remainder for improvements. Rural areas showed about 16 percent for ROW and engineering.

Funds disbursed for improvement types during the 2 year period 1986 through 1987 are described in Tables II-7 through II-10. The tables are split between the Federal-aid systems and the functional systems. In rural areas, funds were distributed in the following order: 3R; new construction; bridge; reconstruction; safety; and major widening.

Although the order in which funds were distributed in rural areas remained unchanged since the two year period 1984 through 1985, the magnitude of expenditures did change, suggesting renewed emphasis on capacity enhancement. New construction increased 24 percent (increasing its share of total disbursements from 22 percent to 26 percent); major widening and safety also increased by about 25 percent; reconstruction dropped by 10 percent; and 3R decreased by 7 percent. Only bridge expenditures remained relatively unchanged.

In urban areas funds during the two year period 1986 through 1987 were distributed in the following order: new construction; 3R; reconstruction; bridge; major widening; and safety. The share of funds directed to new construction rose from 29 percent during the two year period 1984 through 1985 to 35 percent in the two year period 1986 through 1987; the funding level increased $1.9 billion. The percentage share of funds directed to the other categories changed by less than 5 percent during the two periods. However, disbursements for bridges increased 37 percent from $1.9 billion to $2.6 billion.

In urban areas, the Interstate receives the highest share of capital improvement disbursements. In rural areas Federal-aid primary roads dominate funding with 51 percent of the disbursements as compared to only 28 percent spent on the Interstates.

Distinctions between rural and urban disbursements are noteworthy. While new construction was the predominate use of funds in urban areas (35 percent), 3R was the most important type of improvement in rural areas (34 percent).

Disbursements on the Federal-aid system (Tables II-7 and II-8) show that urban Interstate receives 45 percent of the funds in contrast to rural Interstate with only 28 percent (compared to rural primary receiving over half). Fully three quarters of funds on the Federal-aid system, in aggregate, were used on the primary system (including the Interstate).

TABLE II-1
TOTAL RECEIPTS FOR HIGHWAYS BY GOVERNMENT JURISDICTION FOR SELECTED YEARS 1960-1987 1/

(In millions of dollars)

Year	Federal		State		Local		Total Receipts
	Receipts	Percent	Receipts	Percent	Receipts	Percent	
1960	3,063	26.7	6,055	52.7	2,367	20.6	11,485
1962	3,364	26.4	6,904	54.1	2,484	19.5	12,752
1964	3,907	28.5	7,192	52.5	2,594	18.9	13,693
1966	4,720	28.6	8,723	52.8	3,072	18.6	16,515
1968	5,064	27.2	10,036	53.9	3,534	19.0	18,634
1970	6,144	28.3	11,737	54.0	3,866	17.8	21,747
1971	6,584	27.1	13,359	55.1	4,317	17.8	24,260
1972	6,286	25.7	13,551	55.3	4,646	19.0	24,483
1973	7,419	27.8	14,288	53.5	4,996	18.7	26,703
1974	7,846	28.4	14,238	51.6	5,498	19.9	27,582
1975	7,676	26.3	15,105	51.8	6,379	21.9	29,160
1976	8,038	26.1	16,126	52.3	6,667	21.6	30,831
1977	9,230	27.8	16,700	50.2	7,313	22.0	33,243
1978	9,750	27.5	17,766	50.0	7,988	22.5	35,504
1979	10,560	27.7	18,507	48.6	9,018	23.7	38,085
1980	9,830	24.8	19,666	49.5	10,219	25.7	39,715
1981	10,338	24.2	21,044	49.3	11,311	26.5	42,693
1982	10,110	22.9	22,078	50.1	11,867	26.9	44,055
1983	11,684	24.3	23,918	49.8	12,471	25.9	48,073
1984	14,698	26.9	26,550	48.6	13,388	24.5	54,636
1985	14,749	24.1	30,543	49.9	15,933	26.0	61,225
1986	14,826	22.7	32,338	49.5	18,209	27.8	65,373
1987	14,466	21.7	32,788	49.3	19,290-2/	29.0	66,544

1/ Highway Statistics, HF-11.
2/ HF-10, September 1988 (includes some estimates).

TABLE II-2
TOTAL DISBURSEMENTS FOR HIGHWAYS BY ALL LEVELS OF GOVERNMENT 1/, 2/
1960 - 1987

(In millions of dollars)

Year	Federal		State		Local		Total	
	Amount	Percent Change 3/	Amount	Percent Change 3/	Amount	Percent Change 3/	Amount	Percent Change 3/
1960	2,753	-14.95	5,438	6.54	1,969	1.76	10,160	-1.13
1961	2,941	6.83	5,818	6.99	2,068	5.03	10,827	6.56
1962	3,173	7.89	6,314	8.53	2,136	3.29	11,623	7.35
1963	3,759	18.47	6,395	1.28	2,166	1.40	12,320	6.00
1964	4,278	13.81	6,548	2.39	2,159	-0.32	12,985	5.40
1965	4,137	-3.30	7,065	7.90	2,254	4.40	13,456	3.63
1966	4,610	11.43	7,643	8.18	2,530	12.24	14,783	9.86
1967	4,390	-4.77	8,507	11.30	2,807	10.95	15,704	6.23
1968	4,822	9.84	9,069	6.61	3,021	7.62	16,912	7.69
1969	4,557	-5.50	9,842	8.52	3,205	6.09	17,604	4.09
1970	5,200	14.11	10,970	11.46	3,413	6.49	19,583	11.24
1971	5,658	8.81	11,760	7.20	3,781	10.78	21,199	8.25
1972	5,428	-4.07	12,548	6.70	3,953	4.55	21,929	3.44
1973	5,440	0.22	13,281	5.84	4,067	2.88	22,788	3.92
1974	6,155	13.14	13,696	3.12	4,821	18.54	24,672	8.27
1975	7,224	17.37	14,263	4.14	5,720	18.65	27,207	10.27
1976	7,853	8.71	13,964	-2.10	5,921	3.51	27,738	1.95
1977	7,621	-2.95	14,365	2.87	6,198	4.68	28,184	1.61
1978	8,397	10.18	16,248	13.11	7,196	16.10	31,841	12.98
1979	10,200	21.47	17,870	9.98	7,623	5.93	35,693	12.10
1980	11,826	15.94	19,020	6.44	9,238	21.19	40,084	12.30
1981	11,097	-6.16	19,371	1.85	9,956	7.77	40,424	0.85
1982	10,504	-5.34	20,167	4.11	10,610	6.57	41,281	2.12
1983	10,955	4.29	22,023	9.20	11,014	3.81	43,992	6.57
1984	12,958	18.28	23,384	6.18	11,971	8.69	48,313	9.82
1985	15,008	15.82	26,096	11.60	13,695	14.40	54,799	13.42
1986	15,168	1.07	28,961	10.98	15,429	12.66	59,558	8.68
1987	14,638	-3.49	31,154	7.58	17,721-4/	14.86	63,513	6.64

1/ Highway Statistics, HF-11 and HF-12.
2/ Excludes debt retirement, but includes interest on debt.
3/ From previous year.
4/ HF-10, September 1988 (includes some estimates).

TABLE II-3
DISBURSEMENTS FOR HIGHWAYS BY FUNCTIONS 1/
ALL UNITS OF GOVERNMENTS
1960 - 1987
(In millions of dollars)

Year	Capital Outlay	Maintenance and Operations	Administration etc.	Highway Patrol and Safety	Interest on Debt	Subtotal Current Disbursements	Debt Retirement	Total
1960	6,290	2,640	483	327	420	10,160	601	10,761
1961	6,800	2,728	522	348	429	10,827	665	11,492
1962	7,386	2,839	537	383	478	11,623	679	12,302
1963	7,893	2,918	586	423	500	12,320	732	13,052
1964	8,252	3,060	684	474	515	12,985	752	13,737
1965	8,368	3,289	751	524	524	13,456	855	14,311
1966	9,246	3,517	815	669	536	14,783	915	15,698
1967	9,661	3,772	906	777	588	15,704	965	16,669
1968	10,346	4,003	1,017	940	606	16,912	1,071	17,983
1969	10,373	4,331	1,110	1,109	681	17,604	1,170	18,774
1970	11,575	4,720	1,275	1,303	710	19,583	1,252	20,835
1971	12,306	5,114	1,436	1,503	840	21,199	1,281	22,480
1972	12,275	5,443	1,600	1,671	950	21,939	1,270	23,209
1973	12,165	5,949	1,735	1,891	1,041	22,781	1,405	24,186
1974	13,102	6,573	1,857	2,061	1,079	24,672	1,445	26,117
1975	14,398	7,286	1,981	2,431	1,129	27,225	1,492	28,717
1976	13,927	7,735	2,209	2,633	1,234	27,738	1,567	29,305
1977	13,079	8,612	2,370	2,842	1,281	28,184	1,648	29,832
1978	14,938	9,785	2,590	3,160	1,368	31,841	1,593	33,434
1979	17,612	10,571	2,726	3,359	1,425	35,693	1,751	37,444
1980	20,337	11,445	3,022	3,824	1,456	40,084	1,711	41,795
1981	19,734	12,165	3,439	3,884	1,202	40,424	2,464	42,888
1982	19,052	13,319	3,152	4,068	1,690	41,281	2,046	43,327
1983	20,224	14,240	3,347	4,309	1,872	43,992	2,172	46,164
1984	23,123	15,008	3,604	4,937	1,641	48,313	2,411	50,724
1985	26,647	16,589	4,174	5,241	2,148	54,799	2,737	57,536
1986	29,177	17,654	4,677	5,548	2,502	59,558	2,793	62,351
1987-2/	30,997	18,993	4,966	5,841	2,716	63,513	2,806	66,319

1/ Highway Statistics, HF-12.
2/ Includes estimates, HF-10, September 1988.

TABLE II-4
1986 STATE HIGHWAY CAPITAL EXPENDITURES 1/, 2/, 3/
ON AND OFF THE FEDERAL-AID SYSTEM

(In millions of dollars)

	On Federal-Aid System		Off Federal-aid System	Total
	Federal Participating 4/	Non-Federal Participating		
Rural Disbursements	$ 6,959	$ 2,383	$ 739	$ 10,081
Percent rural total	69.03	23.64	7.33	100.00
Percent rural of total disbursements	33.96	11.63	3.61	49.20
Urban Disbursements	$ 8,277	$ 1,818	$ 314	$ 10,409
Percent urban total	79.52	17.47	3.02	100.00
Percent urban of total disbursements	40.40	8.87	1.53	50.80
Total Disbursements	$ 15,236	$ 4,201	$ 1,053	$ 20,490
Percent total	74.36	20.50	5.14	100.00

1/ Expenditures by local governments not included. Data includes arterial and collector highways.
2/ Includes right-of-way, preliminary engineering, construction, and toll road expenditure. Data from FHWA-534 reports.
3/ Data represents 50 States.
4/ Totals include State matching funds.

TABLE II-5
1987 STATE HIGHWAY CAPITAL EXPENDITURES-1/, 2/, 3/
ON AND OFF THE FEDERAL-AID SYSTEM

(In millions of dollars)

	On Federal-Aid System		Off Federal-aid System	Total
	Federal Participating 4/	Non-Federal Participating		
Rural Disbursements	$ 6,221	$ 3,000	$ 545	$ 9,766
Percent rural total	63.70	30.72	5.58	100.00
Percent rural of total disbursements	29.83	14.39	2.61	46.83
Urban Disbursements	$ 8,403	$ 2,090	$ 593	$ 11,086
Percent urban total	75.80	18.85	5.35	100.00
Percent urban of total disbursements	40.30	10.02	2.84	53.17
Total Disbursements	$ 14,624	$ 5,090	$ 1,138	$ 20,852
Percent total	70.13	24.41	5.46	100.00

1/ Expenditures by local governments not included. Data includes arterial and collector highways.
2/ Includes right-of-way, preliminary engineering, construction, and toll road expenditure. Data from FHWA-534 reports.
3/ Data represents 50 States.
4/ Totals include State matching funds.

TABLE II-6
COMPARISON OF 1986 AND 1987 STATE HIGHWAY CAPITAL DISBURSEMENTS 1/, 2/
FOR CONDITION IMPROVEMENTS AND ROW AND ENGINEERING

(In millions of dollars)

	1986		1987		Total 1986-1987 Disburse-ments
	Dollars	Percent	Dollars	Percent	
Rural Disbursements					
Condition Improvements	$ 8,445	41.21	$ 8,119	38.93	$ 16,564
ROW and Engineering	1,636	7.98	1,647	7.90	3,283
Total Rural	$ 10,081	49.20	$ 9,766	46.83	$ 19,847
Urban Disbursements					
Condition Improvements	$ 8,035	39.21	$ 8,758	42.00	$ 16,793
ROW and Engineering	2,375	11.59	2,330	11.17	4,705
Total Urban	$ 10,410	50.80	$ 11,088	53.17	$ 21,498
Rural and Urban Disbursements					
Condition Improvements	$ 16,480	80.43	$ 16,877	80.93	$ 33,357
ROW and Engineering	4,011	19.57	3,977	19.07	7,988
Total Rural and Urban	$ 20,491	100.00	20,854	100.00	$ 41,345

1/ Disbursements by local governments not included.
2/ Data includes arterial and collecter highways.

TABLE II-7
RURAL CAPITAL DISBURSEMENTS BY FEDERAL AND STATE GOVERNMENTS,
BY IMPROVEMENT TYPE AND FEDERAL-AID SYSTEM 1986-1987 1/, 2/, 3/, 5/

(In millions of dollars)

Type of Improvement	FEDERAL-AID SYSTEM			Off-Federal System 4/	Total
	Interstate	Primary	Secondary		
New Construction	$ 1,431	$ 2,321	$ 498	$ 93	$ 4,343
% by System	32.95	53.44	11.47	2.14	100.00
% of All Improvements	30.47	27.44	18.25	13.64	26.22
% of Total Expenditures	8.64	14.01	3.01	0.56	26.22
Reconstruction	$ 520	$ 1,166	$ 363	$ 112	$ 2,161
% by System	24.06	53.96	16.80	5.18	100.00
% of All Improvements	11.07	13.78	13.30	16.42	13.04
% of Total Expenditures	3.14	7.04	2.19	0.68	13.04
Major Widening	$ 280	$ 650	$ 71	$ 18	$ 1,019
% by System	27.48	63.79	6.97	1.77	100.00
% of All Improvements	5.96	7.68	2.60	2.64	6.15
% of Total Expenditures	1.69	3.92	0.43	0.11	6.15
RRR	$ 1,728	$ 2,667	$ 1,029	$ 228	$ 5,652
% by System	30.57	47.19	18.21	4.03	100.00
% of All Improvements	36.80	31.53	37.71	33.43	34.12
% of Total Expenditures	10.43	16.10	6.21	1.38	34.12
Bridge	$ 425	$ 1,162	$ 542	$ 196	$ 2,325
% by System	18.28	49.98	23.31	8.43	100.00
% of All Improvements	9.05	13.74	19.86	28.74	14.03
% of Total Expenditures	2.57	7.01	3.27	1.18	14.03
Safety and Other	$ 312	$ 493	$ 226	$ 35	$ 1,066
% by System	29.27	46.25	21.20	3.28	100.00
% of All Improvements	6.64	5.83	8.28	5.13	6.43
% of Total Expenditures	1.88	2.98	1.36	0.21	6.43
Total	$ 4,696	$ 8,459	$ 2,729	$ 682	$ 16,566
% by System	28.35	51.06	16.47	4.12	100.00
% of All Improvements	100.00	100.00	100.00	100.00	100.00
% of Total Expenditures	28.35	51.06	16.47	4.12	100.00

1/ Does not include ROW and engineering.
2/ Includes Interstate completion.
3/ Includes 50 States in 1986 and 48 States in 1987.
4/ Includes arterials and collector highways.
5/ Totals may not agree with Table II-9 due to slight rounding errors.

TABLE II-8
URBAN CAPITAL DISBURSEMENTS BY FEDERAL AND STATE GOVERNMENTS,
BY IMPROVEMENT TYPE AND FEDERAL-AID SYSTEM 1986-1987 1/, 2/, 3/, 4/

(In millions of dollars)

Type of Improvement	FEDERAL-AID SYSTEM			Off-Federal System	Total
	Interstate	Primary	Urban		
New Construction	$ 3,034	$ 1,680	$ 1,129	$ 8	$ 5,851
% by System	51.85	28.72	19.29	0.14	100.00
% of All Improvements	40.34	38.20	23.42	20.00	34.87
% of Total Expenditures	18.08	10.01	6.73	0.05	34.87
Reconstruction	$ 1,292	$ 545	$ 855	$ 12	$ 2,704
% by System	47.78	20.16	31.62	0.44	100.00
% of All Improvements	17.18	12.39	17.74	30.00	16.11
% of Total Expenditures	7.70	3.25	5.09	0.07	16.11
Major Widening	$ 626	$ 285	$ 429	$ 1	$ 1,341
% by System	46.68	21.22	32.03	0.07	100.00
% of All Improvements	8.32	6.47	8.91	2.50	7.99
% of Total Expenditures	3.73	1.70	2.56	0.01	7.99
RRR	$ 1,192	$ 799	$ 976	$ 4	$ 2,971
% by System	40.12	26.89	32.85	0.13	100.00
% of All Improvements	15.85	18.16	20.25	10.00	17.7
% of Total Expenditures	7.10	4.76	5.82	0.02	17.71
Bridge	$ 902	$ 707	$ 967	$ 9	$ 2,585
% by System	34.89	27.35	37.41	0.35	100.00
% of All Improvements	11.99	16.07	20.07	22.50	15.41
% of Total Expenditures	5.38	4.21	5.76	0.05	15.41
Safety and Other	$ 476	$ 383	$ 463	$ 6	$ 1,328
% by System	35.84	28.86	34.85	0.45	100.00
% of All Improvements	6.33	8.71	9.60	15.00	7.91
% of Total Expenditures	2.84	2.28	2.76	0.04	7.91
Total	$ 7,522	$ 4,399	$ 4,819	$ 40	$ 16,780
% by System	44.83	26.21	28.72	0.24	100.00
% of All Improvements	100.00	100.00	100.00	100.00	100.00
% of Total Expenditures	44.83	26.21	28.72	0.24	100.00

1/ Does not include ROW and engineering.
2/ Includes Interstate completion.
3/ Includes 50 States in 1986 and 48 States in 1987.
4/ Totals may not agree with Table II-10 due to slight rounding errors.

TABLE II-9
RURAL CAPITAL DISBURSEMENTS BY FEDERAL AND STATE GOVERNMENTS,
BY IMPROVEMENT TYPE AND FUNCTIONAL SYSTEM 1986-1987 1/, 2/, 3/

(In millions of dollars)

Type of Improvement	FUNCTIONAL SYSTEM					
	Interstate	Other Principal Arterials	Minor Arterials	Major Collectors	Minor Collectors	Total
New Construction	$ 1,431	$ 1,768	$ 553	$ 498	$ 93	$ 4,343
% by System	32.95	40.71	12.73	11.47	2.14	100.00
% of All Improvements	30.47	36.39	15.36	18.27	13.64	26.22
% of Total Expenditures	8.64	10.67	3.34	3.01	0.56	26.22
Reconstruction	$ 520	$ 604	$ 562	$ 363	$ 112	$ 2,161
% by System	24.06	27.95	26.01	16.80	5.18	100.00
% of All Improvements	11.07	12.43	15.61	13.32	16.42	13.05
% of Total Expenditures	3.14	3.65	3.39	2.19	0.68	13.05
Major Widening	$ 280	$ 445	$ 205	$ 71	$ 18	$ 1,019
% by System	27.48	43.67	20.12	6.97	1.77	100.00
% of All Improvements	5.96	9.16	5.69	2.60	2.64	6.15
% of Total Expenditures	1.69	2.69	1.24	0.43	0.11	6.15
RRR	$ 1,728	$ 1,251	$ 1,416	$ 1,028	$ 228	$ 5,651
% by System	30.58	22.14	25.06	18.19	4.03	100.00
% of All Improvements	36.80	25.75	39.33	37.71	33.43	34.12
% of Total Expenditures	10.43	7.55	8.55	6.21	1.38	34.12
Bridge	$ 425	$ 529	$ 633	$ 541	$ 196	$ 2,324
% by System	8.29	22.76	27.24	23.28	8.43	100.00
% of All Improvements	9.05	10.89	17.58	19.85	28.74	14.03
% of Total Expenditures	2.57	3.19	3.82	3.27	1.18	14.03
Safety and Other	$ 312	$ 262	$ 231	$ 225	$ 35	$ 1,065
% by System	29.30	24.60	21.69	21.13	3.29	100.00
% of All Improvements	6.64	5.39	6.42	8.25	5.13	6.43
% of Total Expenditures	1.88	1.58	1.39	1.36	0.21	6.43
Total	$ 4,696	$ 4,859	$ 3,600	$ 2,726	$ 682	$ 16,563
% by System	28.35	29.34	21.74	16.46	4.12	100.00
% of All Improvements	100.00	100.00	100.00	100.00	100.00	100.00
% of Total Expenditures	28.35	29.34	21.74	16.46	4.12	100.00

1/ Does not include ROW & engineering.
2/ Includes Interstate completion.
3/ Totals may not agree with Table II-7 due to slight rounding errors.

TABLE II-10
URBAN CAPITAL DISBURSEMENTS BY FEDERAL AND STATE GOVERNMENTS,
BY IMPROVEMENT TYPE AND FUNCTIONAL SYSTEM 1986-1987 1/, 2/, 3/

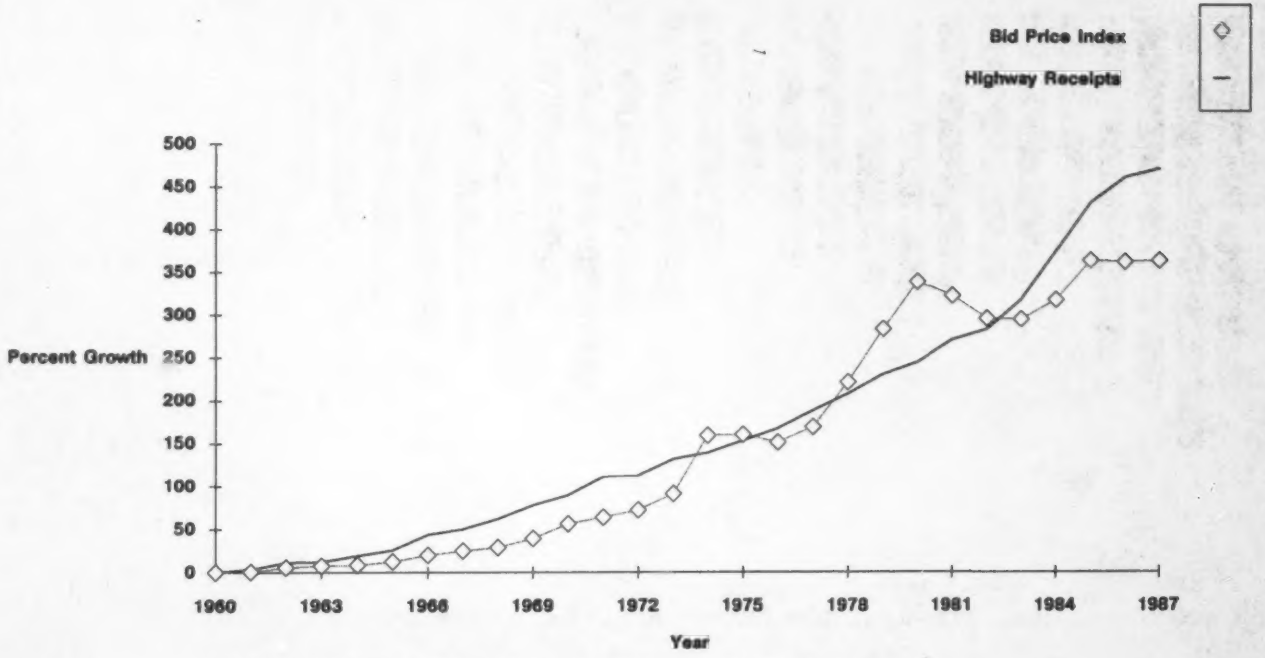
(In millions of dollars)

Type of Improvement	FUNCTIONAL SYSTEM					
	Interstate	Other Freeways and Expressways	Other Principal Arterials	Minor Arterials	Collectors	Total
New Construction	$ 3,034	$ 1,276	$ 1,088	$ 357	$ 96	$ 5,851
% by System	51.85	21.81	18.60	6.10	1.64	100.00
% of All Improvements	40.34	47.21	27.29	18.43	4.96	34.86
% of Total Expenditures	18.08	7.60	6.48	2.13	0.57	34.86
Reconstruction	$ 1,292	$ 248	$ 647	$ 365	$ 151	$ 2,703
% by System	47.80	9.17	3.94	13.50	5.59	100.00
% of All Improvements	17.18	9.17	6.23	18.84	7.80	16.11
% of Total Expenditures	7.70	1.48	3.86	2.17	0.90	16.11
Major Widening	$ 626	$ 118	$ 359	$ 184	$ 54	$ 1,341
% by System	46.68	8.80	26.77	13.72	4.03	100.00
% of All Improvements	8.32	4.37	9.00	9.50	2.79	7.99
% of Total Expenditures	3.73	0.70	2.14	1.10	0.32	7.99
RRR	$ 1,192	$ 461	$ 779	$ 411	$ 130	$ 2,973
% by System	40.09	15.51	26.20	13.82	4.37	100.00
% of All Improvements	15.85	17.06	19.54	21.22	6.71	17.72
% of Total Expenditures	7.10	2.75	4.64	2.45	0.77	17.72
Bridge	$ 902	$ 384	$ 732	$ 452	$ 116	$ 2,586
% by System	34.88	14.85	28.31	17.48	4.49	100.00
% of All Improvements	11.99	14.21	18.36	23.34	5.99	15.41
% of Total Expenditures	5.37	2.29	4.36	2.69	0.69	15.41
Safety and Other	$ 476	$ 216	$ 382	$ 168	$ 86	$ 1,328
% by System	35.84	16.27	28.77	12.65	6.48	100.00
% of All Improvements	6.33	7.99	9.58	8.67	4.44	7.91
% of Total Expenditures	2.84	1.29	2.28	1.00	0.51	7.91
Total	$ 7,522	$ 2,703	$ 3,987	$ 1,937	$ 633	$ 16,782
% by System	44.82	16.11	23.76	11.54	3.77	100.00
% of All Improvements	100.00	100.00	100.00	100.00	32.68	100.00
% of Total Expenditures	44.82	16.11	23.76	11.54	3.77	100.00

1/ Does not include ROW & engineering.
2/ Includes Interstate completion.
3/ Totals may not agree with Table II-8 due to slight rounding errors.

FIGURE II-1

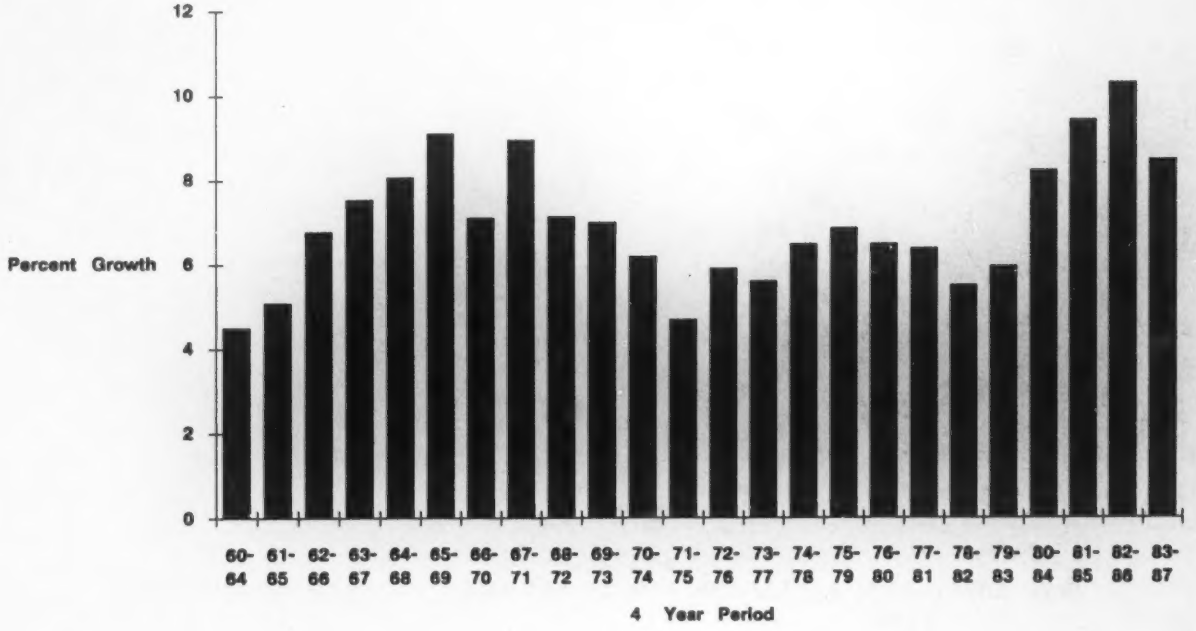
COMPARISON OF PERCENT GROWTH IN HIGHWAY RECEIPTS AND THE BID PRICE INDEX - 1960-1987



Note: The BPI is an indicator of inflation in highway construction costs.

FIGURE II-2

AVERAGE ANNUAL GROWTH OF HIGHWAY RECEIPTS DURING FOUR YEAR PERIODS
1960-1987



CHAPTER III

HIGHWAY CONDITIONS AND PERFORMANCE

Summary

- In 1987 there were 3.87 million miles of streets and highways in the Nation. For the period 1985 to 1987 (in this chapter, all time periods run from midyear to midyear), rural mileage decreased by 7,000 miles (0.2 percent). This is attributed to the continued reclassification of certain United States Forest Service roads and the continued redefinition of certain areas from rural to urban from the 1980 Census.

- Total national travel in 1987 reached 1.92 trillion vehicle miles - an increase of 8.4 percent over 1985. In 1987 the Interstate System, which represents only 1.1 percent of the total highway mileage, carried over 21 percent of the total travel.

- Since the last report, the growth in travel has been most pronounced in the New England (12.2 percent) and the Northern Southeast (11.8 percent) regions. The smallest increases in travel occurred in the Rocky Mountain (4.0 percent) and the Pacific (4.9 percent) regions.

- Interstate highways and other arterial highways continued to experience significant congestion during 1987. The percent of peak hour travel on urban Interstates that occurred under congested conditions reached 65 percent. The percent of peak hour travel on urban other arterials that occurred under congested conditions reached 42 percent. In 1985, these figures were 61 percent and 40 percent respectively. However, the capacity calculations used in 1987 differ from those used in 1985, making comparison of the two inappropriate.

- For the period 1985 through 1987, the percentage of pavements in poor condition (currently in need of capital improvements) decreased on the arterial and collector systems, remained stable on urban Interstates, and increased on rural Interstates. The percentage of pavements in good or excellent condition decreased on each functional system except rural collectors.

- The percentage of bridges classified as being deficient has increased over the period 1982-88. The proportion of Interstate bridges classified as being deficient rose from 10.6 percent in 1982, to 13.1 percent in 1984, to 14.3 percent in 1986, and to 15.9 percent in 1988.

- In 1987 the rates of highway accident fatalities decreased for urban Interstate highways, urban arterials, urban collectors, and rural collectors while increasing on rural Interstate highways and rural arterials. The rates ranged from a high of 4.03 fatalities per 100 million VMT on rural collectors to a low of 0.87 on urban Interstate highways.

- For the period 1985 to 1987, the total unit cost of travel decreased by an estimated 1.0 percent to $617.32 per 1,000 vehicle miles of travel. This is a reversal of the increases in unit costs experienced immediately prior to the passage of the STAA of 1982.

Introduction

The material in this chapter includes those features of the major highways that affect performance. Included is information about system mileage and travel, travel growth, and the condition of the various systems in terms of pavement, bridges, congestion levels, and accidents. The chapter also investigates the changes in highway user costs resulting from the changing highway conditions.

The information has been developed primarily from data supplied by the State transportation agencies via the HPMS. These data, updated annually by the States, provide the FHWA with information about highway physical conditions and usage. Data about pavement, roadway cross-section, alignment, and usage are collected for several sample sections of highway in each State. The HPMS data are the primary sources of information for the Federal Government about the Nation's highway infrastructure. Because of the statistical imprecision inherent in any sample based data collection system, such as the HPMS, the relative changes in conditions over time should be considered more reliable than the absolute value of any condition.

Another data system used to develop information for this chapter is the national bridge inventory. This inventory is updated continuously by the States, and includes detailed information about all highway bridges in the country. This

information aids in the monitoring and managing of the national bridge program.

The material presented in this chapter has, in general, been aggregated to the national level to describe the relative differences between highway systems and changes that are occurring on those systems over time. Most of the data are available at the State level as well. The annual FHWA publication titled Highway Statistics contains information about the physical condition and usage of highways at the individual State level.

The latest data presented on highway physical conditions, other than the bridge data, were collected in 1987 and represent conditions that existed during that year. Because of the time needed to collect and process the data, reporting of the information is delayed about 1 year. Since bridge data is continuously updated, 1988 figures for deficient bridges are available and are used in this report.

The primary stratification of information on conditions and travel in this chapter is by functional system at the national level; however, another section is also included which looks at conditions across the Federal-aid system categories. Information is presented in six major sections. "Mileage and Travel" describes the extent of the highway system and the vehicle miles of travel on it. "Operating Characteristics" describes the level of congestion experienced on the highway system. "Physical Conditions" summarizes the physical characteristics of the highway network and their changes over time. "Safety" looks at the fatality rates across functional systems and deficiencies that exist among the various functional systems. "The Federal-Aid System" section briefly describes the physical and operating characteristics of the highway network from a Federal-aid stratification perspective. Finally, the section titled "User Impact Changes" describes the changes in highway user costs since the last report as an indicator of the composite changes in highway performance. Preceding these six sections is a list of definitions for terms that are commonly used throughout this chapter.

Definitions

Throughout this chapter, certain technical terms appear that may not be familiar to all readers. The following is a list of the most frequently used terms and their definitions.

Vehicle-Miles-Traveled (VMT) - an aggregate measure of travel taking place on all or part of a highway system. It is the summation of all miles traveled by all vehicles during a fixed period of time on a fixed expanse of highway(s).

Volume - The number of vehicles that pass over a given point of a lane or roadway during a specified time period.

Service Flow (formerly **Capacity**) - The theoretical maximum number of vehicles that has a reasonable expectation of passing over a given section of a lane of a roadway in one direction (or in both directions for a two-lane or three-lane highway) during a given time period under prevailing roadway and traffic conditions.

Volume to Service Flow Ratio (V/SF) - A factor used in determining congestion levels on a section of highway. It compares the volume of traffic on a particular section of highway to its theoretical service flow for a particular time period. A V/SF ratio of 0.80 or higher usually indicates unstable traffic flow conditions (congestion).

Present Serviceability Ratings (PSR) - An index used to rate the quality of the pavement surface. The rating is based on a visual inspection of the surface compared to an established scale that ranges from 0 to 5, where 0 indicates extraordinary pavement deterioration and a rating of 5 represents pavement that is in perfect condition. See Figure III-1 for a more complete definition of PSR.

Deficiency - A performance element that is at or below a specified minimum level. These minimum levels represent a consensus of technical expertise within the highway engineering discipline.

Structurally Deficient Bridge - A bridge that has been restricted to light vehicles only, closed, or requires immediate rehabilitation to keep it open.

Functionally Obsolete Bridge - A bridge on which the deck geometry, load carrying capacity, clearance, or approach roadway alignment can no longer safely service the system of which it is an integral part.

Mileage and Travel

Both highway mileage and travel have increased steadily over the past several years. Table III-1 contains a comparison of the highway mileage by functional system for the years 1983, 1985, and 1987. In 1987, there were 3.87 million miles of public streets and highways in the Nation. Although over 81 percent of these roads are classified as rural, rural mileage has decreased in each period since 1983. For the period 1985 to 1987, rural mileage decreased by 7,000 miles (0.2 percent). This decrease continues to be attributed to the reclassification of certain United States Forest Service roads to non-public roadways and the reclassification of some areas from rural to urban. In contrast, urban mileage increased by 19,000 miles (2.8 percent) over the same period.

Travel comparisons are found in Table III-2. In 1987, total national travel reached 1.92 trillion vehicle miles, an increase of 8.4 percent over 1985. For the same period, travel grew on all functional systems, ranging from a high of 13.4 percent on urban Interstates to a low of 1.4 percent on urban local streets. Urban Interstates, rural Interstates, urban other freeways and expressways, and urban minor arterials all showed growth in excess of 10 percent. In 1987, the Interstate System, which comprises only 1.1 percent of the total highway mileage, carried over 21 percent of the total travel.

Urban travel increased by 9.4 percent from 1985 through 1987, and it represented 59.4 percent of total travel in 1987. Table III-2 contains comparisons of urban and rural travel. While it appears that urban travel has increased significantly more than rural travel, part of the urban travel increase is directly attributable to the increase in urban mileage. In contrast, rural travel also increased, but rural mileage decreased. To present a clearer picture of the change in travel, Table III-3 contains the changes in daily vehicle miles of travel per mile of highway. The figures in this table shows that on a "per mile" basis for the period 1985 through 1987, the increase in rural travel (7.3 percent) was actually greater than the increase in urban travel (6.4 percent).

The levels of travel for each State and each region for the years 1983, 1985, and 1987 are shown in Tables III-4 and III-5. An examination of this data indicates that travel has continued to increase in every region of the country. Since the last report, the growth in travel has been most pronounced in the New England (12.2 percent) and the Northern Southeast (11.8 percent) regions.

The only regions that experienced under 5 percent growth in travel were the Pacific (4.9 percent) and the Rocky Mountain (4.0.percent) regions.

Operating Characteristics

The continuing growth of travel described above is causing a proportionate growth of peak-hour congestion on our Nation's highways. Table III-6 contains the levels of peak-hour congestion on the various functional systems for the years 1983, 1985, and 1987. This table includes both peak-hour mileage and travel that occurred with volume to service flow ratios greater than or equal to 0.80. Significant changes in rural congestion are apparent. These figures are misleading, however, because while some of these changes can be attributed to changes in travel, a large portion of them are due to a change in the calculation of service flow. Prior to the 1986 HPMS data submittal, service flow (then capacity) was calculated as prescribed in the 1965 Highway Capacity Manual (HCM). Starting with the 1986 HPMS data submittal, service flow calculations from the 1985 HCM were used. As a result of using the 1985 HCM, rural freeway service flow decreased while service flow on the lower systems increased. Due to the change in service flow calculations, comparison of rural congestion figures for 1987 with previous years becomes inappropriate. With these new calculations, peak-period travel on rural Interstate that occurred under congested conditions reached 17 percent in 1987.

Whereas rural service flow is calculated by HPMS submittal software (and therefore calculated using the 1985 HCM method), urban service flow is submitted directly by the States. It is estimated that about half of the States continued using the 1965 HCM method for their 1987 data. Therefore, the urban figures for 1987 found in Table III-6 may not accurately reflect urban congestion. However, since urban travel increased by 9.4 percent from 1985 through 1987, it is likely that urban congestion has also increased. With the mixture of service flow calculations, congested peak-period travel on the urban Interstate System reached 65 percent in 1987.

Physical Conditions

Following the above discussion of mileage and travel, we now look at the physical condition of the highways themselves. Perhaps the most important indicator of the physical condition of our Nation's highways is the condition of their pavements. Figure III-1 contains a description of the rating system used to

qualify pavement condition. Using this rating system, the distribution of ratings for pavement condition (PSR) from 1983 through 1987 are found in Table III-7. The first column contains the percentages of mileage on each functional system where the PSR values were less than or equal to 2.0 (less than or equal to 2.5 for Interstate highways which have a higher standard of performance). Highways in this category are below accepted condition levels and currently need improvement. For the arterial and collector systems, the percentage of poor pavement has declined since the last report, continuing the trend of improving pavement condition brought about by, among other things, the STAA of 1982. However, the rural Interstate System increased somewhat over the same period, with 11.6 percent of its mileage having a PSR of 2.5 or less (compared to 10.8 percent in 1985). The urban Interstate System remained stable with 11.1 percent of its mileage having a PSR of 2.5 or less. The second column (PSR less than or equal to 3.0) includes those highways that either were, or would soon be, in need of improvements. For this category three of the six functional systems have shown improvement since the last report. The third column contains the percentages of pavements that are in very good or excellent condition. Here only one functional system has shown improvement since the last report.

Table III-8 provides a look at the changes in pavement condition from a different perspective. This table contains a cross-classification of the pavement conditions from a set of individual HPMS sample sections that were included and could be identified in both years of two study periods. For the period 1985 through 1987, the figures in this table show that 83.9 percent of Interstate mileage remained in fair or good condition (PSR of 2.6 or higher) while only 6.3 percent remained in poor condition (PSR of 2.5 or lower). For the same period, 88.7 percent of "other arterials" mileage remained in good or fair condition (PSR of 2.1 or higher) while 4.1 percent remained in poor condition (PSR of 2.0 or lower). For the "other arterials," the percentage of pavements that improved to fair or good during the period was greater than the percentage that declined to poor. However, the opposite was true for the Interstate System.

Table III-9 contains the percentage of Interstate mileage with deficient pavement in each State during 1987. The figures in this table demonstrate that while improvements are being made nationally, significant variation exists among States. While several States report having no deficient Interstate pavement whatsoever, 5 other States report that 30 percent or more of their total Interstate pavement is deficient.

There are other physical highway characteristics in addition to pavement condition that have a major effect on highway performance. Among these are alignment adequacy and lane width, both of which contribute to the service flow and safety of a highway. An examination of both horizontal and vertical alignment adequacy on rural highway mileage for 1987 is contained in Table III-10. The rating system used for alignment adequacy is found at the bottom of this table. Less than 1 percent of rural Interstate mileage has horizontal alignment adequacy ratings of Code 3 or 4 (the lesser ratings). In contrast, over 35 percent of minor collector mileage had a rating of Code 3 or worse. Parallel distributions are found in the vertical alignment adequacy ratings.

Table III-11 contains the same type of information for the distributions of lane widths. Over 99 percent of the rural Interstate mileage has a lane width of 12 feet or more. This figure drops to 84 percent for the other principal arterials, 61 percent for minor arterials, 31 percent for major collectors, and only 14 percent for minor collectors. In fact, over 10 percent of the rural minor collector mileage has lane widths of less than 9 feet. However, only a little over 7 percent of rural travel occurs on these roads. Once again, the higher service functional systems with the higher travel densities generally have the better physical characteristics.

Bridge conditions also show a marked difference across the functional classes. The proportions of bridges that are classified as being structurally deficient or functionally obsolete are found in Tables III-12 through III-14. It should be noted, however, that these tables contain only those bridges that are eligible for the Highway Bridge Replacement and Rehabilitation Program (HBRRP). In 1988, 15.9 percent of the Interstate bridges were classified as being deficient, compared to 28.5 percent on the other arterials, and 38.1 percent on the collector system. The proportion of deficient Interstate bridges increased over the most recent period from 14.3 percent in 1986 to 15.9 percent in 1988. On the arterial and collector systems, the proportion of deficient bridges remained fairly stable over the same period.

Safety

The physical conditions described above are among the many factors that affect highway safety. Table III-15 shows the recent improvements that have been made in highway safety. This table contains highway fatality rates for the years 1977 through 1987. Although these rates were on the rise for most of the functional

systems in the late seventies, steady improvement has taken place over the last several years. For the most recent period, 1986 through 1987, the fatality rates dropped on the urban Interstate System, the urban arterial system, the urban collector system, and the rural collector system. For the same period, the fatality rates increased slightly on the rural Interstate System and the rural arterial system. In 1987, these rates ranged from a low of 0.87 fatalities per 100 million VMT on the urban Interstate System to a high of 4.03 fatalities per 100 million VMT on the rural collector system. These fatality rates tend to be higher on the rural systems primarily due to the higher travel speeds that are experienced there.

Table III-16 contains listings of mileage having single and multiple highway deficiencies for 1987. This table quantifies the various combinations of deficiencies that exist on the various functional systems. It should be noted that mileage with deficiencies appears in the table only once. For example, mileage that has only pavement deficiencies will not appear again with mileage that has pavement and geometric deficiencies. Some correlation can be made between these deficiencies and the fatality rates found in Table III-15: the rural collector system, which had the highest fatality rate, had some type of deficiency on over 30 percent of its mileage. Rural Interstate mileage was the best of the functional systems, with almost 75 percent of its mileage containing no deficiencies.

The Federal-Aid System

All previously discussed information in this chapter has been aggregated by functional system. This section will examine some of the same types of information aggregated by Federal-aid system designation. In order to relate the Federal-aid system to the various functional systems, Table III-17 contains a cross-classification of highway mileage by functional system and Federal-aid system designation. This table shows that only 21.9 percent (under 850,000 miles) of the National highway network is designated as part of the Federal-aid system.

The entire Interstate System is part of the Federal-aid system. Its 44,328 miles comprise 5.2 percent of all Federal-aid mileage. The majority of this Interstate mileage, almost 75 percent, lies in rural areas.

The primary system, excluding the Interstate System, contains 258,120 miles and comprises 30.4 percent of total Federal-aid

mileage. It is also primarily rural, with 87 percent of its mileage being in rural areas. All of the primary system mileage is functionally classified as arterial or freeway and expressway.

The Federal-aid urban system (FAUS) contains 147,979 miles and represents 17.4 percent of the total Federal-aid mileage. The FAUS is comprised of urban collectors (37.9 percent) and non-Interstate urban arterials (62.1.percent).

The secondary system contains 398,329 miles of roadway. It represents 47 percent of total Federal-aid mileage. The entire secondary system is functionally classified as rural major collector.

Table III-18 contains a comparison of the mileage, travel, and travel per mile for each of the Federal-aid categories. Between 1985 and 1987, travel on the Federal-aid highways increased by 8 percent in rural areas and by 11 percent in urban areas. As a group, the Federal-aid highways represented slightly less than 22 percent of the national mileage but carried almost 82 percent of the total travel. The density of travel per mile in rural areas was 17 times higher for highways that were on the Federal-aid system than for those that were off the Federal-aid system, and in urban areas density on the Federal-aid system was 12 times greater than it was off the Federal-aid system.

Tables III-19 through III-21 contain the estimated distributions across Federal-aid categories for pavement condition, alignment adequacy,and lane width. It should be noted that these estimates are based on a sample that was not specifically drawn to represent Federal-aid categories, and furthermore that the sample does not contain any local highways, which comprise 89 percent of the off-system category. The distributions across Federal-aid system categories is similar to that previously described for the functional systems in that the better conditions are found on the higher order systems.

User Impact Changes

Changes in pavement and bridge condition, congestion levels, and highway geometrics affect the costs involved in using the Nation's roads and streets. These highway user costs, both private and commercial, eventually impact the national economy through transportation costs for goods and services. This section provides a discussion of the changes in highway user costs as an indicator of composite changes in highway performance.

Changes in highway conditions and performance affect the costs incurred by highway users in using the Nation's road system. These costs, both private and commercial, are either absorbed by the highway user or passed along to consumers in the form of higher costs for goods and services that rely extensively on the highway system. Eventually, both of these types of cost impact the Nation's economy.

The HPMS analytical process contains an impact assessment module that calculates the effects of traffic density, pavement type and condition, curvature, and grade on several performance indicators. Among the most important of these indicators are:

1. Operating costs per 1,000 VMT (by functional system and vehicle type).

2. The rates of total accidents, fatal accidents, and non-fatal injury accidents (per 100 million VMT; by functional system).

3. The expected average travel speeds (by functional system and vehicle type).

Each of these model estimates represents a separate component of the total economic cost of highway travel. Since the data are expressed in different units (dollars per 1,000 VMT, accidents per 100 million VMT, and miles per hour) they cannot readily be combined into a single measure of overall highway performance. A single measure is useful for comparing the relative costs of a given investment level with the resulting benefits from that investment.

When analyzing the component user costs, it is important to recognize the very subjective nature of assigning monetary costs to the tragedy of accidental death or injury, or to the lost opportunity of spent time. Calculations of the value of time are admittedly debatable, and must always be considered imprecise. More importantly, the personal loss and suffering that result from accidental injury or death cannot be measured. As a result, the cost estimates used in this analysis are explicitly limited to the economic costs that are experienced by society.

Table III-22 shows how the unit costs of travel changed from 1985 through 1987. During this period, the total unit cost of travel decreased by an estimated 1.0 percent from $623.61 per 1,000 VMT to $617.32 per 1,000 VMT (as measured in 1985 dollars). Unit

travel costs declined on each functional system except urban minor arterials, which increased slightly. The greatest improvement occurred on the urban other freeways and expressways (-1.5 percent). Unit cost on urban minor arterials increased by 0.5 percent. Looking at individual components, the greatest improvement occurred in accident costs (-1.3 percent), followed by operating costs (-1.1 percent). Time costs showed no improvements, and in fact increased by 0.9 percent. This increase can be attributed to the steadily growing level of urban congestion discussed earlier in this chapter.

When considering these results, it is important to remember that they are not actually measured changes in user costs, but instead, are calculated estimates of the changes based on the net impact of changing highway conditions. The model results are more valid in describing the direction of change than in measuring either the actual levels of user costs or the precise magnitude of their changes. Still, the model's uniform estimates of reduced user costs across the majority of the functional systems and two of the three cost components imply a real improvement in the effective performance of the Nation's streets and highways in response to the additional capital improvements made possible by, among other things, the STAA of 1982. This improvement is further reinforced when we consider that user costs had increased by an estimated 1.3 percent between 1980 and 1983, the period immediately prior to the increased construction undertaken as a result of the STAA of 1982.

Figure III-1

Present Serviceability Rating (PSR)

PSR	Verbal Rating	Description
5	Very Good	Only new (or nearly new) pavements are likely to be smooth enough and sufficiently free of cracks and patches to qualify for this category. All pavements constructed or resurfaced recently should be rated in this category.
4	Good	Pavements in this category, although not quite as smooth as those described above, give first class ride and exhibit few, if any, visible signs of surface deterioration. Flexible pavements may be beginning to show evidence of rutting and fine random cracks. Rigid pavements may be beginning to show evidence of slight surface deterioration, such as minor cracks and spalling.
3	Fair	The riding qualities of pavements in this category are noticeably inferior to those of new pavements, and may be barely tolerable for high-speed traffic. Surface defects of flexible pavements may include rutting, map cracking, and more or less extensive patching. Rigid pavements in this group may have a few joint failures, faulting and cracking, and some pumping.
2	Poor	Pavements that have deteriorated to such an extent that they are in need of resurfacing.
1	Very Poor	Pavements which are in an extremely deteriorated condition and may even need complete reconstruction.
0		

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TABLE III-1

HIGHWAY MILEAGE COMPARISON BY YEAR AND FUNCTIONAL SYSTEM (1983-1987)

RURAL	1983	1985	1987	PERCENT CHANGE 1985-1987
INTERSTATE	32,788	32,761	33,111	1.1
OTHER PRINCIPAL ARTERIAL	81,234	80,719	80,719	0.0
MINOR ARTERIAL	147,536	146,583	147,254	0.5
MAJOR COLLECTOR	434,166	432,753	435,413	0.6
MINOR COLLECTOR	300,172	296,636	294,799	-0.6
SUBTOTAL	995,896	989,452	991,296	0.2
LOCAL	2,221,392	2,181,535	2,172,542	-0.4
RURAL TOTAL	3,217,288	3,170,987	3,163,838	-0.2
URBAN				
INTERSTATE	10,240	10,832	11,217	3.6
OTHER FREEWAY/EXPRESSWAY	7,024	7,170	7,390	3.1
OTHER PRINCIPAL ARTERIAL	47,330	49,895	50,483	1.2
MINOR ARTERIAL	69,108	72,177	74,984	3.9
COLLECTOR	72,513	75,370	76,860	2.0
SUBTOTAL	206,215	215,444	220,934	2.5
LOCAL	456,135	475,503	489,254	2.9
URBAN TOTAL	662,350	690,947	710,188	2.8
NATIONAL TOTAL	3,879,638	3,861,934	3,874,026	0.3

SOURCE: 1983-87 Highway Statistics.

TABLE III-2

HIGHWAY TRAVEL COMPARISON BY YEAR AND FUNCTIONAL SYSTEM (1983-1987)

(Travel in millions of annual vehicle miles)

RURAL	1983	1985	1987	PERCENT CHANGE 1985-1987
INTERSTATE	144,733	154,148	171,866	11.5
OTHER PRINCIPAL ARTERIAL	139,962	145,903	155,446	6.5
MINOR ARTERIAL	133,421	136,854	146,528	7.1
MAJOR COLLECTOR	156,786	163,197	174,176	6.7
MINOR COLLECTOR	43,806	43,345	44,488	2.6
SUBTOTAL	618,708	643,447	692,504	7.6
LOCAL	81,825	86,868	89,243	2.7
RURAL TOTAL	700,533	730,315	781,747	7.0
URBAN				
INTERSTATE	191,149	216,441	245,339	13.4
OTHER FREEWAY/EXPRESSWAY	86,790	97,351	109,900	12.9
OTHER PRINCIPAL ARTERIAL	255,327	279,025	304,673	9.2
MINOR ARTERIAL	188,467	201,738	224,107	11.1
COLLECTOR	86,593	89,531	95,964	7.2
SUBTOTAL	808,326	884,086	979,983	10.8
LOCAL	140,247	160,361	162,597	1.4
URBAN TOTAL	948,573	1,044,447	1,142,580	9.4
NATIONAL TOTAL	1,649,106	1,774,762	1,924,327	8.4

SOURCE: Highway Statistics, 1983-87.

TABLE III-3

DAILY TRAVEL PER HIGHWAY MILE BY YEAR AND FUNCTIONAL SYSTEM (1983-1987)

(Thousands of daily VMT per mile)

RURAL	1983	1985	1987	PERCENT CHANGE 1985-1987
INTERSTATE	12.09	12.89	14.22	10.3
OTHER PRINCIPAL ARTERIAL	4.72	4.95	5.28	6.5
MINOR ARTERIAL	2.48	2.56	2.73	6.6
MAJOR COLLECTOR	0.99	1.03	1.10	6.1
MINOR COLLECTOR	0.40	0.40	0.41	3.3
SUBTOTAL	1.70	1.78	1.91	7.4
LOCAL	0.10	0.11	0.11	3.2
RURAL TOTAL	0.60	0.63	0.68	7.3
URBAN				
INTERSTATE	51.14	54.74	59.92	9.5
OTHER FREEWAY/EXPRESSWAY	33.85	37.20	40.74	9.5
OTHER PRINCIPAL ARTERIAL	14.78	15.32	16.53	7.9
MINOR ARTERIAL	7.47	7.66	8.19	6.9
COLLECTOR	3.27	3.25	3.42	5.1
SUBTOTAL	10.74	11.24	12.15	8.1
LOCAL	0.84	0.92	0.91	-1.5
URBAN TOTAL	3.92	4.14	4.41	6.4

Derived from Tables III-1 and III-2.

TABLE III-4

HIGHWAY TRAVEL (MILLIONS OF VMT) BY STATE AND YEAR (1983-1987)

STATE	1983	1985	1987	PERCENT CHANGE (85-87)
ALABAMA	31,032	35,091	37,426	6.7
ALASKA	3,358	3,840	3,900	1.6
ARIZONA	19,611	21,580	31,729	47.0
ARKANSAS	16,684	17,112	18,306	7.0
CALIFORNIA	182,652	207,600	226,301	9.0
COLORADO	24,109	26,146	26,968	3.1
CONNECTICUT	20,630	22,152	26,775	20.9
DELAWARE	4,886	5,365	6,086	13.4
DISTRICT OF COLUMBIA	3,099	3,223	3,368	4.5
FLORIDA	81,776	88,056	93,639	6.3
GEORGIA	48,837	53,713	60,293	12.3
HAWAII	5,873	6,762	7,218	6.7
IDAHO	8,287	7,710	8,119	5.3
ILLINOIS	67,370	70,844	75,756	6.9
INDIANA	39,837	40,782	44,122	8.2
IOWA	19,661	20,191	20,808	3.1
KANSAS	18,153	19,275	20,561	6.7
KENTUCKY	26,719	28,520	30,320	6.3
LOUISIANA	27,573	33,365	30,599	-8.3
MAINE	7,924	9,277	10,766	16.1
MARYLAND	30,618	33,337	36,493	9.5
MASSACHUSETTS	37,541	39,696	42,305	6.6
MICHIGAN	60,855	67,402	75,706	12.3
MINNESOTA	31,063	32,688	35,167	7.6
MISSISSIPPI	17,802	19,130	20,173	5.5
MISSOURI	36,543	39,284	43,379	10.4
MONTANA	7,181	7,572	8,074	6.6
NEBRASKA	11,534	12,054	13,091	8.6
NEVADA	6,872	7,566	8,396	11.0
NEW HAMPSHIRE	7,181	7,538	9,167	21.6
NEW JERSEY	52,217	53,108	57,071	7.5
NEW MEXICO	11,678	13,269	15,116	13.9
NEW YORK	83,783	90,518	98,002	8.3
NORTH CAROLINA	45,038	49,923	54,600	9.4
NORTH DAKOTA	5,363	5,387	5,681	5.5
OHIO	73,214	75,549	79,157	4.8
OKLAHOMA	29,565	31,181	31,606	1.4
OREGON	20,557	21,458	23,332	8.7
PENNSYLVANIA	72,302	75,428	78,626	4.2
RHODE ISLAND	6,014	5,823	6,003	3.1
SOUTH CAROLINA	24,977	26,677	30,224	13.3
SOUTH DAKOTA	6,317	6,277	6,209	-1.1
TENNESSEE	36,261	36,258	42,126	16.2
TEXAS	131,883	143,263	151,186	5.5
UTAH	11,221	12,037	12,679	5.3
VERMONT	4,151	4,688	5,039	7.5
VIRGINIA	42,299	47,928	54,834	14.4
WASHINGTON	36,144	34,375	38,520	12.1
WEST VIRGINIA	11,696	12,664	13,742	8.5
WISCONSIN	34,106	36,679	40,196	9.6
WYOMING	5,059	5,401	5,367	-0.6
TOTALS	1,649,106	1,774,762	1,924,327	8.4

SOURCE: Highway Statistics, 1983-87.

TABLE III-5

HIGHWAY TRAVEL (MILLIONS OF VMT) BY REGION, STATE AND YEAR (1983-1987)

NEW ENGLAND	1983	1985	1987	PERCENT CHANGE (85-87)
CONNECTICUT	20,630	22,152	26,775	20.9
MAINE	7,924	9,277	10,766	16.1
MASSACHUSETTS	37,541	39,696	42,305	6.6
NEW HAMPSHIRE	7,181	7,538	9,167	21.6
RHODE ISLAND	6,014	5,823	6,003	3.1
VERMONT	4,151	4,688	5,039	7.5
REGION TOTALS	83,441	89,174	100,055	12.2
MIDEAST				
DELAWARE	4,886	5,365	6,086	13.4
DISTRICT OF COLUMBIA	3,099	3,223	3,368	4.5
MARYLAND	30,618	33,337	36,493	9.5
NEW JERSEY	52,217	53,108	57,071	7.5
NEW YORK	83,783	90,518	98,002	8.3
PENNSYLVANIA	72,302	75,428	78,626	4.2
REGION TOTALS	246,905	260,979	279,646	7.2
NORTHERN SOUTHEAST				
KENTUCKY	26,719	28,520	30,320	6.3
NORTH CAROLINA	45,038	49,923	54,600	9.4
SOUTH CAROLINA	24,977	26,677	30,224	13.3
TENNESSEE	36,261	36,258	42,126	16.2
VIRGINIA	42,299	47,928	54,834	14.4
WEST VIRGINIA	11,696	12,664	13,742	8.5
REGION TOTALS	186,990	201,970	225,846	11.8
SOUTHERN SOUTHEAST				
ALABAMA	31,032	35,091	37,426	6.7
ARKANSAS	16,684	17,112	18,306	7.0
FLORIDA	81,776	88,056	93,639	6.3
GEORGIA	48,837	53,713	60,293	12.3
LOUISIANA	27,573	33,365	30,599	-8.3
MISSISSIPPI	17,802	19,130	20,173	5.5
REGION TOTALS	223,704	246,467	260,436	5.7
GREAT LAKES				
ILLINOIS	67,370	70,844	75,756	6.9
INDIANA	39,837	40,782	44,122	8.2
MICHIGAN	60,855	67,402	75,706	12.3
OHIO	73,214	75,549	79,157	4.8
WISCONSIN	34,106	36,679	40,196	9.6
REGION TOTALS	275,382	291,256	314,937	8.1
PLAINS				
IOWA	19,661	20,191	20,808	3.1
KANSAS	18,153	19,275	20,561	6.7
MINNESOTA	31,063	32,688	35,167	7.6
MISSOURI	36,543	39,284	43,379	10.4
NEBRASKA	11,534	12,054	13,091	8.6
NORTH DAKOTA	5,363	5,387	5,681	5.5
SOUTH DAKOTA	6,317	6,277	6,209	-1.1
REGION TOTALS	128,634	135,156	144,896	7.2

TABLE III-5 (CONT.)

SOUTHWEST	1983	1985	1987	PERCENT CHANGE (85-87)
ARIZONA	19,611	21,580	31,729	47.0
NEW MEXICO	11,678	13,269	15,116	13.9
OKLAHOMA	29,565	31,181	31,606	1.4
TEXAS	131,883	143,163	151,186	5.6
REGION TOTALS	192,737	209,293	229,637	9.7
ROCKY MOUNTAIN				
COLORADO	24,109	26,146	26,968	3.1
IDAHO	8,287	7,710	8,119	5.3
MONTANA	7,181	7,572	8,074	6.6
UTAH	11,221	12,037	12,679	5.3
WYOMING	5,059	5,401	5,367	-0.6
REGION TOTALS	55,857	58,866	61,207	4.0
FAR WEST				
CALIFORNIA	182,652	207,600	226,301	9.0
NEVADA	6,872	7,566	8,396	11.0
OREGON	20,557	21,458	23,332	8.7
WASHINGTON	36,144	34,375	38,520	12.1
REGION TOTALS	246,225	270,999	296,549	9.4
PACIFIC				
ALASKA	3,358	3,840	3,900	1.6
HAWAII	5,873	6,762	7,218	6.7
REGION TOTALS	9,231	10,602	11,118	4.9
NATIONAL TOTALS	1,649,106	1,774,762	1,924,327	8.4

SOURCE: Highway Statistics, 1983-87.

Table III-6

1983-1987 PROPORTIONS OF HIGHWAY MILEAGE AND PEAK HOUR TRAVEL WITH VOLUME TO SERVICE FLOW RATIOS OVER 0.80 DURING PEAK PERIODS

	PERCENT OF MILEAGE			PERCENT OF PEAK HOUR VMT		
RURAL	1983	1985	1987	1983	1985	1987
INTERSTATE	2.60	2.90	7.01	7.80	8.43	17.16
OTHER ARTERIALS	2.30	2.59	1.47	8.84	9.45	6.05
COLLECTORS	0.52	0.52	0.18	5.27	5.26	2.58
URBAN						
INTERSTATE	29.39	35.96	39.77	54.35	60.96	65.45
OTHER ARTERIALS	20.79	22.05	23.41	38.33	39.99	42.24
COLLECTORS	6.75	6.82	6.44	22.60	20.89	18.91

NOTE: Large changes in rural congestion between 1985 and 1987 are a result of variations in the computation of service flow. In the 1985 (and earlier) HPMS datasets, service flow was calculated as prescribed in the 1965 Highway Capacity Manual. Starting with the 1986 HPMS dataset, service flow is calculated as prescribed in the 1985 Highway Capacity Manual.

SOURCE: 1983-87 HPMS Master Datasets.

TABLE III-7

ESTIMATED HIGHWAY MILEAGE
BY PAVEMENT CONDITION, YEAR (1983 - 1987) AND FUNCTIONAL SYSTEM

(In percent)

FUNCTIONAL SYSTEM AND YEAR	PRESENT SERVICEABILITY RATING[1] (1) LESS THAN OR EQUAL TO 2.0[2]	(2) LESS THAN OR EQUAL TO 3.0	(3) GREATER THAN OR EQUAL TO 4.0
RURAL INTERSTATE			
1983	13.1	26.1	31.8
1985	10.8	24.1	33.8
1987	11.6	27.2	29.9
URBAN INTERSTATE			
1983	17.5	33.9	30.1
1985	11.1	29.0	35.3
1987	11.1	29.0	29.4
RURAL OTHER ARTERIALS			
1983	10.6	43.6	20.1
1985	8.3	38.9	23.8
1987	6.0	37.9	22.1
URBAN OTHER ARTERIALS			
1983	10.1	48.6	21.6
1985	9.0	46.9	24.2
1987	8.1	44.6	22.9
RURAL COLLECTORS			
1983	17.2	56.9	15.2
1985	16.5	58.6	15.6
1987	14.5	54.1	16.8
URBAN COLLECTORS			
1983	15.9	58.1	16.1
1985	13.4	56.4	16.7
1987	13.0	56.9	16.1

NOTE: The pavement service rating categories above represent: (1) pavement that needs improvement, (2) pavement that needs or may soon need improvement, and (3) pavement that is in very good condition. The categories are not sequentially exclusive and intentionally do not sum to 100 percent.

SOURCE: HPMS Master Datasets, Summary Tables Runs, 1983-87.

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[1]Refer to Figure III-1 for an explanation of PSR values.

[2]Less than 2.5 for Interstate.

TABLE III-8

CHANGES IN PAVEMENT CONDITION RATINGS ON INDIVIDUAL HIGHWAY SECTIONS

	MILEAGE BASIS[1]	REMAINED FAIR OR GOOD (percent)	IMPROVED TO FAIR OR GOOD (percent)	REMAINED POOR (percent)	DECLINED TO POOR (percent)
INTERSTATE					
1983 - 1985	33,662	83.5	6.3	6.0	4.2
1985 - 1987	36,325	83.9	4.7	6.3	5.1
OTHER ARTERIALS					
1983 - 1985	293,575	86.0	5.2	5.2	3.6
1985 - 1987	301,587	88.7	4.1	4.1	3.1

[1]Based on analysis of HPMS sample sections that were included and identified in both years of the given study period. For the Interstate, the category "Fair to Good" includes PSR ratings of 2.6 and higher; "Poor" is 2.5 and below. For the other arterials, "Fair to Good" includes ratings of 2.1 and above, while "Poor" is 2.0 or less.

TABLE III-9

DEFICIENT (PSR <= 2.5) INTERSTATE MILEAGE FOR 1987

STATE	RURAL MILES	PERCENT DEFICIENT	URBAN MILES	PERCENT DEFICIENT	TOTAL MILES	PERCENT DEFICIENT
ALABAMA	622	0.2	258	0.0	880	0.1
ALASKA	1,041	42.0	48	37.5	1,089	41.8
ARIZONA	1,044	12.6	117	18.8	1,161	13.3
ARKANSAS	419	4.3	123	4.9	542	4.4
CALIFORNIA	1,416	8.7	973	7.3	2,389	8.1
COLORADO	790	5.4	152	7.9	942	5.8
CONNECTICUT	109	0.9	233	1.7	342	1.5
DELAWARE	0	NA	41	0.0	41	0.0
DISTRICT OF COLUMBIA	0	NA	12	25.0	12	25.0
FLORIDA	966	9.1	388	0.8	1,354	6.7
GEORGIA	884	17.2	359	9.5	1,243	15.0
HAWAII	5	0.0	34	0.0	39	0.0
IDAHO	534	15.5	71	14.1	605	15.4
ILLINOIS	1,418	3.4	516	8.3	1,934	4.7
INDIANA	851	5.3	266	4.9	1,117	5.2
IOWA	643	13.4	131	22.9	774	15.0
KANSAS	707	11.3	163	9.8	870	11.0
KENTUCKY	579	0.7	173	9.8	752	2.8
LOUISIANA	532	9.4	177	8.5	709	9.2
MAINE	313	8.3	53	13.2	366	9.0
MARYLAND	169	0.0	225	0.4	394	0.3
MASSACHUSETTS	172	0.0	391	5.9	563	4.1
MICHIGAN	766	11.7	444	20.0	1,210	14.8
MINNESOTA	688	4.5	212	0.5	900	3.6
MISSISSIPPI	563	40.9	123	31.7	686	39.2
MISSOURI	840	37.7	337	45.7	1,177	40.0
MONTANA	1,135	8.3	46	28.3	1,181	9.1
NEBRASKA	444	2.0	37	2.7	481	2.1
NEVADA	503	9.1	42	0.0	545	8.4
NEW HAMPSHIRE	180	11.7	42	7.1	222	10.8
NEW JERSEY	126	2.4	267	4.5	393	3.8
NEW MEXICO	899	12.1	99	20.2	998	12.9
NEW YORK	858	1.3	641	12.8	1,499	6.2
NORTH CAROLINA	599	2.2	206	3.4	805	2.5
NORTH DAKOTA	532	26.7	39	8.2	571	25.4
OHIO	847	4.8	718	16.4	1,565	10.2
OKLAHOMA	723	21.9	204	29.9	927	23.6
OREGON	584	37.5	132	25.0	716	35.2
PENNSYLVANIA	1,147	11.1	376	4.0	1,523	9.3
RHODE ISLAND	21	33.3	49	20.4	70	24.3
SOUTH CAROLINA	673	6.7	117	5.1	790	6.5
SOUTH DAKOTA	636	0.0	42	0.0	678	0.0
TENNESSEE	788	41.2	274	22.3	1,062	36.3
TEXAS	2,282	3.9	926	13.6	3,208	6.7
UTAH	752	1.2	137	0.0	889	1.0
VERMONT	300	3.7	20	15.0	320	4.4
VIRGINIA	767	19.6	292	5.1	1,059	15.6
WASHINGTON	514	0.2	240	2.5	754	0.9
WEST VIRGINIA	389	2.1	90	0.0	479	1.7
WISCONSIN	467	27.6	111	12.6	578	24.7
WYOMING	864	0.0	50	4.0	914	0.2
TOTAL	33,111	11.6	11,217	11.1	44,328	11.5

SOURCE: 1987 Highway Statistics.

TABLE III-10

1987 RURAL HIGHWAY MILEAGE BY ALIGNMENT ADEQUACY AND FUNCTIONAL SYSTEM

(In percent)

HORIZONTAL ALIGNMENT ADEQUACY RATINGS

FUNCTIONAL SYSTEM	CODE 1	CODE 2	CODE 3	CODE 4	TOTALS
INTERSTATE	94.2	4.2	1.0	0.6	100
OTHER PRINCIPAL ARTERIAL	75.2	16.2	4.1	4.5	100
MINOR ARTERIAL	67.6	13.5	7.3	11.6	100
MAJOR COLLECTOR	49.0	23.6	15.3	12.1	100
MINOR COLLECTOR	39.2	25.5	20.1	15.2	100
TOTALS	54.4	20.8	13.3	11.5	100

VERTICAL ALIGNMENT ADEQUACY RATINGS

FUNCTIONAL SYSTEM	CODE 1	CODE 2	CODE 3	CODE 4	TOTALS
INTERSTATE	91.7	6.7	0.3	1.3	100
OTHER PRINCIPAL ARTERIAL	66.6	27.3	3.4	2.7	100
MINOR ARTERIAL	54.7	33.2	6.5	5.6	100
MAJOR COLLECTOR	46.5	32.6	14.1	6.8	100
MINOR COLLECTOR	41.8	34.4	15.7	8.1	100
TOTALS	50.6	31.6	11.5	6.3	100

CODE 1: All grades/curves meet appropriate design standards.

CODE 2: Some grades/curves are below design standards for new construction, but curves can be negotiated safely at prevailing speed limit. Truck speed is not substantially affected.

CODE 3: Infrequent grades impair sight distance or affect truck speed. Infrequent curves may have reduced speed limits for safety purposes.

CODE 4: Frequent grades that impair sight distance or severely affect truck speeds. General curves are unsafe and/or uncomfortable at prevailing speed limit, or the speed limit is severely restricted due to the design speeds of the curves.

NOTE: Paved mileage only. Sections for which no alignment data were supplied are treated as CODE 2.

SOURCE: 1987 HPMS Master Dataset, Summary Tables Run.

TABLE III-11

RURAL HIGHWAY MILEAGE BY LANE WIDTH AND FUNCTIONAL SYSTEM

(In percent)

	LESS THAN 9 FEET	9 FEET	10 FEET	11 FEET	MORE THAN 11 FEET	TOTALS
INTERSTATE	0.0	0.0	0.0	0.7	99.3	100
OTHER PRINCIPAL ARTERIAL	0.0	0.3	3.5	11.4	84.8	100
MINOR ARTERIAL	0.3	3.0	14.3	20.3	62.1	100
MAJOR COLLECTOR	3.0	11.5	31.5	21.5	32.5	100
MINOR COLLECTOR	13.5	22.9	29.4	14.7	19.5	100
TOTALS	5.3	12.4	25.0	17.8	39.5	100

RURAL HIGHWAY TRAVEL BY LANE WIDTH AND FUNCTIONAL SYSTEM

(In percent)

	LESS THAN 9 FEET	9 FEET	10 FEET	11 FEET	MORE THAN 11 FEET	TOTALS
INTERSTATE	0.0	0.0	0.0	0.2	99.8	100
OTHER PRINCIPAL ARTERIAL	0.0	0.2	3.2	9.2	87.4	100
MINOR ARTERIAL	0.1	2.4	12.8	21.0	63.7	100
MAJOR COLLECTOR	0.9	8.2	27.3	20.9	42.7	100
MINOR COLLECTOR	7.4	22.7	32.2	18.9	18.8	100
TOTALS	0.7	4.0	12.4	13.1	69.8	100

SOURCE: 1987 Highway Statistics (Mileage).
1987 HPMS Master Dataset, Summary Tables Run (Travel).

TABLE III-12
INTERSTATE BRIDGE DEFICIENCIES, 1982 - 1988

	1982		1984		1986		1988	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
RURAL BRIDGES	26,474		27,261		27,228		29,603	
DEFICIENT BRIDGES	2,405	9.1	2,880	10.6	3,136	11.5	3,640	12.7
STRUCTURAL	809	3.1	1,001	3.7	1,311	4.8	1,503	5.3
FUNCTIONAL	1,596	6.0	1 ,879	6.9	1,825	6.7	2,137	7.5
URBAN BRIDGES	19,903		20,766		21,693		22,827	
DEFICIENT BRIDGES	2,518	12.7	3,396	16.4	3,855	17.8	4,555	20.0
STRUCTURAL	1,048	5.3	1,426	6.9	1,729	8.0	2,353	10.3
FUNCTIONAL	1,470	7.4	1,970	9.5	2,126	9.8	2,202	9.7
TOTAL BRIDGES	46,377		48,027		48,921		51,430	
DEFICIENT BRIDGES	4,923	10.6	6,276	13.1	6,991	14.3	8,195	15.9
STRUCTURAL	1,857	4.0	2,427	5.1	3,040	6.2	4,339	8.4
FUNCTIONAL	3,066	6.6	3,849	8.0	3,951	8.1	3,856	7.5

TABLE III-13
OTHER ARTERIALS BRIDGE DEFICIENCIES, 1982 - 1988

	1982		1984		1986		1988	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
RURAL BRIDGES	74,327		74,323		74,040		73,573	
DEFICIENT BRIDGES	19,088	25.7	19,797	26.6	20,293	27.4	20,705	28.1
STRUCTURAL	6,931	9.3	7,680	10.3	8,436	11.4	8,744	11.9
FUNCTIONAL	12,157	16.4	12,117	16.3	11,857	16.0	11,961	16.3
URBAN BRIDGES	41,843		44,627		46,639		49,133	
DEFICIENT BRIDGES	10,921	26.1	12,873	28.8	13,779	29.5	14,317	29.1
STRUCTURAL	4,772	11.4	5,583	12.5	6,727	14.4	7,618	15.5
FUNCTIONAL	6,149	14.7	7,290	16.3	7,052	15.1	6,699	13.6
TOTAL BRIDGES	116,170		118,950		120,679		122,706	
DEFICIENT BRIDGES	30,009	25.8	32,670	27.5	34,072	28.2	35,022	28.5
STRUCTURAL	11,703	10.1	13,263	11.2	15,163	12.6	16,362	13.3
FUNCTIONAL	18,306	15.8	19,407	16.3	18,909	15.7	18,660	15.2

TABLE III-14
COLLECTOR BRIDGE DEFICIENCIES, 1982 - 1988

	1982		1984		1986		1988	
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT
RURAL BRIDGES	141,503		141,804		146,442		153,180	
DEFICIENT BRIDGES	54,339	38.4	55,926	39.4	57,283	39.1	58,942	38.5
STRUCTURAL	23,130	16.3	24,703	17.4	28,851	19.7	29,829	19.5
FUNCTIONAL	31,209	22.1	31,223	22.0	28,432	19.4	29,113	19.0
URBAN BRIDGES	10,075		10,691		11,510		11,355	
DEFICIENT BRIDGES	3,311	32.9	3,848	36.0	4,151	36.1	3,791	33.4
STRUCTURAL	1,663	16.5	1,812	17.0	2,114	18.4	2,252	19.8
FUNCTIONAL	1,648	16.4	2,036	19.0	2,037	17.7	1,539	13.6
TOTAL BRIDGES	151,578		152,495		157,952		164,535	
DEFICIENT BRIDGES	57,650	38.0	59,774	39.2	61,434	38.9	62,733	38.1
STRUCTURAL	24,793	16.4	26,515	17.4	30,965	19.6	32,081	19.5
FUNCTIONAL	32,857	21.7	33,259	21.8	30,469	19.3	30,652	18.6

TABLE III-15

HIGHWAY FATALITY RATES BY YEAR (1977-1987) AND FUNCTIONAL SYSTEM

(Fatalities per 100 million VMT)

	URBAN		
	INTERSTATE	ARTERIALS	COLLECTORS
1977	1.29	2.56	1.80
1978	1.28	2.60	2.59
1979	1.28	2.52	3.72
1980	1.39	2.59	3.37
1981	1.33	2.73	2.89
1982	1.07	2.38	1.97
1983	1.01	2.21	2.11
1984	1.05	2.24	2.13
1985	0.94	2.16	1.87
1986	0.93	2.12	1.89
1987	0.87	1.99	1.51

	RURAL		
	INTERSTATE	ARTERIALS	COLLECTORS
1977	1.75	4.66	5.09
1978	1.86	4.57	5.78
1979	1.79	4.56	6.01
1980	1.71	4.63	5.38
1981	1.79	4.50	5.04
1982	1.53	3.82	4.42
1983	1.50	3.79	4.03
1984	1.44	3.64	4.01
1985	1.40	3.52	3.98
1986	1.32	3.55	4.14
1987	1.46	3.67	4.03

SOURCE: Fatal Accident Reporting System Annual Reports, 1977-87.

TABLE III-16
1987 Multiple Deficiencies
Percent of Miles and DVMT

RURAL											URBAN					
Interstate Deficiencies		Arterial Deficiencies		Collector Deficiencies							Interstate Deficiencies		Arterial Deficiencies		Collector Deficiencies	
Miles Percent	DVMT Percent	Miles Percent	DVMT Percent	Miles Percent	DVMT Percent	Pave Cond	Geom	X-Sec	Oper-ation	Access	Miles Percent	DVMT Percent	Miles Percent	DVMT Percent	Miles Percent	DVMT Percent
18.1	17.2	5.3	7.8	5.2	2.8	XXX					21.5	15.1	11.5	10.8	5.1	3.3
1.3	0.9	7.7	7.1	13.7	13.0		XXX				0.0	0.0	0.0	0.0	0.0	0.0
0.9	0.8	25.3	17.3	6.0	12.0			XXX			0.5	0.4	16.1	8.7	29.8	22.4
3.9	10.5	0.5	3.0	0.1	1.7				XXX		17.3	30.9	10.5	21.5	3.0	9.8
0.0	0.0	0.0	0.0	0.0	0.0					XXX	0.0	0.0	0.1	0.1	0.0	0.0
0.5	0.4	1.2	1.1	1.9	1.0	XXX	XXX				0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	2.2	1.3	0.6	0.8	XXX	XXX	XXX			0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.1	0.2	0.0	0.0	XXX	XXX	XXX	XXX		0.0	0.0	0.0	0.0	0.0	0.0
0.1	0.1	5.2	4.0	0.5	0.7	XXX		XXX			0.3	0.3	4.4	2.3	3.3	1.9
0.0	0.0	0.0	0.0	0.0	0.0				XXX	XXX	0.0	0.0	0.0	0.0	0.0	0.0
0.2	0.1	9.2	6.0	4.7	8.1		XXX	XXX			0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.1	0.1	0.6	0.0	0.2			XXX	XXX		0.6	1.3	1.8	2.4	0.9	2.6
0.0	0.0	0.0	0.0	0.0	0.0			XXX	XXX	XXX	0.0	0.0	0.0	0.1	0.0	0.0
0.8	2.1	0.1	0.4	0.0	0.0	XXX			XXX		9.5	17.2	2.3	4.7	0.1	0.4
0.0	0.0	0.0	0.1	0.0	0.0	XXX	XXX		XXX		0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.1	0.2	0.0	0.0	XXX		XXX	XXX		0.4	0.8	0.6	0.8	0.0	0.1
0.0	0.0	0.2	0.6	0.0	0.1		XXX	XXX	XXX		0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.1	0.3	0.0	0.0		XXX		XXX		0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0		Remaining combinations				0.0	0.0	0.2	0.2	0.0	0.0
74.1	67.9	42.8	50.1	67.4	59.5		No dificiencies				50.0	33.9	52.4	48.2	57.7	59.3

SOURCE: 1987 NPMS Summary Tables Run.

TABLE III-17

1987 HIGHWAY MILEAGE BY FUNCTIONAL SYSTEM AND FEDERAL-AID SYSTEM

RURAL	INTERSTATE	OTHER PRIMARY	URBAN	SECONDARY	FEDERAL AID TOTAL	NON FEDERAL AID	TOTALS
INTERSTATE	33,111	-	-	-	33,111	-	33,111
OTHER PRINCIPAL ARTERIAL	-	80,012	-	-	80,012	707	80,719
MINOR ARTERIAL	-	145,423	-	-	145,423	1,831	147,254
MAJOR COLLECTOR	-	-	-	398,329	398,329	37,084	435,413
MINOR COLLECTOR	-	-	-	-	-	294,799	294,799
LOCAL	-	-	-	-	-	2,172,542	2,172,542
RURAL TOTALS	33,111	225,435	-	398,329	656,875	2,506,963	3,163,838
URBAN							
INTERSTATE	11,217	-	-	-	11,217	-	11,217
OTHER FREEWAY/EXPRESSWAY	-	6,263	759	-	7,022	368	7,390
OTHER PRINCIPAL ARTERIAL	-	24,891	24,789	-	49,680	803	50,483
MINOR ARTERIAL	-	1,531	66,302	-	67,833	7,151	74,984
COLLECTOR	-	-	56,129	-	56,129	20,731	76,860
LOCAL	-	-	-	-	-	489,254	489,254
URBAN TOTALS	11,217	32,685	147,979	-	191,881	518,307	710,188
TOTALS	44,328	258,120	147,979	398,329	848,756	3,025,270	3,874,026

SOURCE: 1987 Highway Statistics.

TABLE III-18

1987 ESTIMATED MILEAGE AND TRAVEL BY FEDERAL-AID SYSTEM

RURAL	MILEAGE	PERCENT OF TOTAL MILEAGE	ANNUAL VMT (MILLIONS)	PERCENT OF TOTAL VMT	DAILY VMT PER MILE
INTERSTATE	33,111	0.9	171,866	8.9	14,221
PRIMARY	225,435	5.8	297,593	15.5	3,617
SECONDARY	398,329	10.3	166,298	8.6	1,144
SUBTOTAL	656,875	17.0	635,757	33.0	2,652
OFF-SYSTEM	2,506,963	64.7	145,990	7.6	160
RURAL TOTALS	3,163,838	81.7	781,747	40.6	677
URBAN					
INTERSTATE	11,217	0.3	245,339	12.7	59,923
PRIMARY	32,685	0.8	260,276	13.5	21,817
URBAN	147,979	3.8	427,897	22.2	7,922
SUBTOTAL	191,881	5.0	933,512	48.5	13,329
OFF-SYSTEM	518,307	13.4	209,068	10.9	1,105
URBAN TOTALS	710,188	18.3	1,142,580	59.4	4,408
TOTALS	3,874,026	100.0	1,924,327	100.0	1,361

SOURCE: 1987 Highway Statistics.

TABLE III-19

1987 ESTIMATED MILEAGE BY PAVEMENT CONDITION AND FEDERAL-AID SYSTEM[1]

(In percent)

	PAVEMENT SERVICEABILITY RATINGS[2]					
RURAL	0.0-2.0	2.1-2.5	2.6-3.0	3.1-3.9	4.0-5.0	TOTALS
INTERSTATE	5.4	6.2	15.6	42.9	29.9	100
PRIMARY	6.0	11.1	20.8	40.0	22.1	100
SECONDARY	11.0	15.7	22.6	32.4	18.3	100
OFF-SYSTEM	20.4	18.3	23.3	23.7	14.3	100
URBAN						
INTERSTATE	2.4	8.4	18.3	41.3	29.6	100
PRIMARY	5.5	12.1	21.8	37.9	22.7	100
URBAN	10.0	15.4	24.3	29.6	20.7	100
OFF-SYSTEM	15.7	19.1	23.7	25.5	16.0	100

SOURCE: 1987 HPMS Master Dataset.

[1]Estimate only. Based on HPMS expanded sample data set not specifically designed for Federal-aid categorizations. Off-system figures for this table do not include roads functionally classified as "Local." Only roads classified as "Collector" or higher are included in off-system mileage.

[2]Refer to Figure III-1 for an explanation of PSR values.

TABLE III-20

1987 ESTIMATED RURAL HIGHWAY MILEAGE
BY ALIGNMENT ADEQUACY AND FEDERAL-AID SYSTEM

(In percent)

HORIZONTAL ADEQUACY	CODE 1	CODE 2	CODE 3	CODE 4	TOTALS
INTERSTATE	94.2	4.2	1.0	0.6	100
PRIMARY	70.3	14.4	6.2	9.1	100
SECONDARY	48.9	23.7	15.3	12.1	100
OFF-SYSTEM *	40.6	25.1	19.5	14.8	100
VERTICAL ADEQUACY					
INTERSTATE	91.7	6.7	0.3	1.3	100
PRIMARY	58.8	31.2	5.4	4.6	100
SECONDARY	46.4	32.7	14.1	6.8	100
OFF-SYSTEM *	42.8	33.9	15.3	8.0	100

* Based on HPMS sample data set which does not include roads functionally classified as "local". Off-system figures above are limited to those off-system roads classified as "collector" or higher.

CODE 1: All grades/curves meet appropriate design standards.
CODE 2: Some grades/curves are below design standards for new construction, but curves can be negotiated safely at prevailing speed limit. Truck speed is not substantially affected.
CODE 3: Infrequent grades impair sight distance or affect truck speed. Infrequent curves may have reduced speed limits for safety purposes.
CODE 4: Frequent grades that impair sight distance or severely affect truck speeds. General curves are unsafe and/or uncomfortable at prevailing speed limit, or the speed limit is severely restricted due to the design speeds of the curves.

NOTE: Paved mileage only. Sections for which no alignment data were supplied are treated as CODE 2.

SOURCE: 1987 HPMS Master Dataset.

TABLE III-21

1987 ESTIMATED HIGHWAY MILEAGE BY LANE WIDTH AND FEDERAL-AID SYSTEM

(In percent)

RURAL	LESS THAN 9 FEET	9 FEET	10 FEET	11 FEET	12 FEET OR MORE	TOTALS
INTERSTATE	0.0	0.0	0.0	0.7*	99.3	100
PRIMARY	0.2	2.0	10.4	17.1	70.3	100
SECONDARY	2.8	11.3	31.6	21.5	32.8	100
URBAN						
INTERSTATE	0.0	0.0	0.0	0.5*	99.5	100
PRIMARY	0.1	0.5	6.9	11.6	80.5	100
URBAN	1.9	6.2	18.7	15.8	57.4	100

*Reported as "Less than 12 feet."

SOURCE: 1987 HPMS Master Dataset.

TABLE III-22

CHANGES IN UNIT COSTS OF TRAVEL FROM 1985 TO 1987

(In percent)

	OPERATING COSTS	ACCIDENT COSTS	TIME COSTS	TOTAL COSTS
RURAL				
INTERSTATE	-0.3	-3.3	-2.0	-0.9
OTHER PRINCIPAL ARTERIAL	-1.0	-1.7	-1.3	-1.1
MINOR ARTERIAL	-0.4	-1.1	-1.3	-0.8
MAJOR COLLECTOR	-0.4	-0.4	-3.2	-1.4
MINOR COLLECTOR	-0.5	-1.4	-2.6	-1.5
URBAN				
INTERSTATE	-1.7	-2.5	0.7	-0.8
OTHER FREEWAY/EXPRESSWAY	-1.9	0.4	-1.9	-1.8
OTHER PRINCIPAL ARTERIAL	-1.6	-1.2	-1.4	-1.5
MINOR ARTERIAL	0.0	0.6	0.9	0.5
COLLECTOR	0.4	-0.1	-1.2	-0.5
TOTALS	-1.1	-1.3	0.9	-1.0

SOURCE: HPMS Summary Tables and Impact Analysis

CHAPTER IV
HIGHWAY AND BRIDGE NEEDS: 1987-2005

Highway and bridge needs are based on an assessment of current conditions, estimates of the amount and nature of future travel demand, and probable capital and maintenance investments that will be realized through the year 2005.

Chapter III contained information describing current conditions on the Nation's nonlocal roads, providing a cross-sectional analysis of 1987 conditions and a time-series analysis for the period 1983-1987. Data presented in that chapter indicated that the 1987 system of nonlocal roads exhibited a variety of physical and operating problems, including poor pavement, high levels of congestion, inadequate lane and shoulder widths, a safety consideration, and a variety of others. In many cases, significant shares of the mileage of individual highway systems were below a level of performance that is considered by engineering professionals to be the minimum acceptable levels of condition or performance. These minimum levels of performance are established to safeguard public safety and to minimize long-term capital and maintenance costs through the application of cost-effective and timely capital improvements.

This chapter contains a description of the elements of highway and bridge investment requirements analysis, the procedures used, the costs of achieving varying definitions of systems performance, and the user impacts of alternative investment strategies. The intent is to provide decisionmakers with a range of estimates to establish highway and bridge capital programs and budget levels and to evaluate the systems performance implications of alternative strategies.

Future Travel Demand

Travel demand is a function of several demographic and economic factors. These include, among others, national economic and population growth; regional shifts in population and economic activity; changes in the composition of age, sex, and personal income characteristics of the driving population; technological changes, such as vehicular improvements that enhance fuel efficiency; and changes in fuel availability and cost.

The interrelation of these factors, combined with recent trends in travel, will determine the future demand that must be accommodated by the Nation's highway system.

Forecasting is not a precise science. Because of differences in the interpretation of the factors that influence travel, and the reliance of travel forecasts on other types of demographic and economic forecasts, a range of possible future social and economic scenarios is used in this report to reflect upper and lower reasonable expectations for predicted travel.

These estimates reflect an anticipated increase in the absolute amount of highway travel, but with a slowing in the rate of highway travel increase for the period through 2005. This anticipated downturn is expected primarily because of the changing characteristics of the motoring public and the so-called saturation effect of vehicles and vehicle use.

Demographic Changes

Historically, average annual travel per motorist has generally been found to increase with the age of the driver up to about 45 years of age. Average annual travel tapers off for drivers over 45 years of age; by the age of 65, the travel rate is less than half that of the 40-49 year age group. Because of the decline in the birth rate, the longevity of the expanding older population, and the aging of the "baby boomers," the average age of the overall driving population is expected to increase into the 21st century. Even considering the younger than average age of immigrants, 1 in every 3 drivers is expected to be over the age of 55 by the turn of the century. If historical trends in the driving habits of older drivers continue, this demographic shift may be expected to dampen rates of travel growth.

A shift in gender composition among drivers is also anticipated, reflecting the increasing number of female drivers. Historically, women have worked closer to home than men, and have made a larger share of their trips as vehicle passengers, rather than as drivers. Currently, 91 percent of women who work have driver's licenses, compared to 96 percent of men who work. Almost 71 percent of women who work full-time outside of the home drive to work, compared to almost 79 percent of men.

As differences in traditional job classifications change, and as the disparity between male and female wage compensation is

reduced, however, travel characteristics of women may reasonably be expected to more closely approach those of men in coming years.

There remain differences in opinion among professionals as to the ultimate effect of these changes in demography on travel demand. For example, there is increasing evidence that older Americans are becoming, as a group, more affluent and healthier. The increased disposable personal income and physical capacity for travel may tend towards higher rates of travel among the elderly than experienced in the past.

There is also evidence that, even though more women may be expected to work outside of the home, their motivations for travel may remain centered around household responsibilities. Trips to satisfy household maintenance purposes are generally shorter, though more frequent than business oriented travel.

Driver Licensing, Vehicle Ownership, and the Saturation Effect

Another factor that is expected to contribute to the decline in the rate of growth of travel is the saturation effect of drivers and vehicles. Today about 85 percent of the adult American population is licensed to drive. Among drivers in the 25 to 35-year age group, almost 95 percent are licensed. The opportunity for substantial new additions to the driver pool is limited.

The emergence of women in the labor force has had the single greatest impact on the rate of change in driver licensing. At all age groups the licensing rate for women is lower than the rate for men, particularly in the older age groups. While the driver licensing rate for men has remained fairly constant over time, there has been a significant increase in the licensing rate for women. In 1983, almost 78 percent of women had a drivers license, compared to almost 61 percent in 1969. The licensing rate for men increased from 87 to 90 percent during this same period.

The differential in driver licensing between men and women is expected to decline as more women enter the out-of-home labor force. Even so, considering the current high rate of total licensing, the impact of additional women drivers will be mitigated as saturation of the universe of potential drivers occurs. By the turn of the century, if not before, virtually every American of driving age will have, or have the opportunity for, a driver license.

While driver licensing rates have increased over time, the number of vehicles available to the average household has also grown. In 1969, the average household owned 1.2 automobiles, vans, or light trucks; this figure increased to an average of 1.7 vehicles in 1983. The number of households without an automobile, van, or light truck decreased from 41 percent in 1950 to 13 percent in 1980. Over the same period, the percentage of households with two or more vehicles increased from 7 percent to 52 percent. One in five households that owned personal use vehicles in 1980 had three or more vehicles.

Trends in vehicle ownership, use, and licensing from 1969 to 1983 are shown in Table IV-1. The number of miles per household increased by 26 percent and the number of vehicles per household by 42 percent over this period, even though average household size declined by over 15 percent. While household size declined, average vehicle ownership per household increased to 1.68 vehicles and number of drivers per household increased to 1.71 drivers.

There has been a significant increase in travel propensity in recent decades, up to the most recent years, as shown in Table IV-1. The future, however, is clouded by a diversity of opinion regarding the basic determinants of highway travel, from womens' participation in employment outside of the home, to household size, to changes in travel behavior by different age groups. For these reasons, this report uses a range of travel futures to capture the probable high and low forecasts that may reasonably be anticipated through the year 2005.

All travel estimates used in this report are based on the 1987 State HPMS submittals. Each State reports actual travel and forecasts travel through the year 2005 by functional system of highway. The national compilation of all State forecasts results in an average annual national travel growth rate of 2.34 percent for all nonlocal roads. The rates vary by State and by functional system within each State.

In order to reflect the uncertainties of economics and demographics discussed above, the estimated 2.34-percent growth rate was adjusted downward to 2.0 percent to reflect a lower than expected travel scenario, and adjusted upwards to 3.0 percent to reflect a higher-than-expected scenario. In addition, the lower and higher estimates were adjusted slightly, using a macroeconomic model, to reflect the economic interdependence of States and

regions. The effect of this adjustment was to reduce the variation in forecast travel between adjacent States and among States that share economic similarities. The actual forecast values used for each State in the analysis are included as Appendix A.

The forecast distribution of travel by functional system was not adjusted within each State. A table showing the current distribution of travel by functional system and the forecast distribution is included in Appendix A. The reader will note that the aggregate State forecasts, none of which are required to be prepared using any prescribed procedure, imply future variability in travel demand by functional system. Historically, as urban areas grow in size and population, the share of total daily travel carried on higher type, limited-access facilities increases. The result of this travel demand shift will become evident later in this chapter under the discussion of needs by functional system and improvement type.

By way of comparison, both the high and the low forecast rates used in this report are lower than recent years' experience in highway travel growth. For the period 1966-1987, the rate of growth in highway travel averaged 3.5 percent annually. Except for the periods 1973-1974 and 1979-1982, the years of the radical fuel price adjustments attributable to the OPEC cartel and the recession of the early 1980's, travel growth has exceeded 3.5 percent in each year since 1966 (Table IV-2).

Procedures Used for Estimating Existing and Future Highway Deficiencies

The first step in assessing future highway capital investment requirements is to simulate the effect of future years' travel on the existing highway network. To accomplish this, the Highway Performance Monitoring System (HPMS) database and analytical process are used.

The HPMS database contains approximately 100,000 sample highway segments, statistically sampled by the States to represent traffic volume groups by functional system within the rural and urban portions of each State. Data for these samples relating to highway physical conditions, safety, and operating characteristics are compiled by the States and submitted to FHWA annually, along with information regarding any capital investments made on the segment.

This database, accumulated to provide a time-series view of highway conditions and performance, is used to assess conditions, calculate future deficiencies, and to estimate capital investment requirements. Continuing efforts at refinement, enhancement, and verification of the individual data items provide highway decisionmakers with a remarkably consistent and flexible tool for developing and evaluating alternative programs, testing future scenarios, and describing the social and economic impacts of changes in highway conditions and performance.

Simulation of future system deterioration, for each of the travel scenarios previously discussed, is performed by applying anticipated travel to each HPMS sample section and simulating the combined impacts of this travel, along with normal weathering and aging, on the section's physical and operating characteristics. The degree and rate of physical deterioration varies by functional system, depending primarily on the system's pavement type and thickness; drainage adequacy; and the amount and type of travel demand. The rate of performance deterioration is based primarily on the number and widths of available lanes, traffic volume and type, curves and grades, and speed change cycles.

The relationships between highway conditions and travel demand and weathering have been developed jointly by the FHWA and the State transportation agencies through research conducted over a period extending over 30 years. The relationships are continuously updated as additional, more refined information is made available through research efforts in this and other countries.

The simulation on each HPMS sample section is carried out in yearly increments. At each simulated yearly interval, the resulting conditions and performance are compared against a prescribed set of minimum condition standards (MCS). Tables IV-3 and 4 contain the MCS's for each functional system used in this report. The MCS's used here have not changed since the last biennial conditions and performance report to Congress (1987), although the internal procedures have changed regarding calculation of highway capacity, as discussed in Chapter III.

The selection of MCS's is based on a consensual approach that approximates an engineering assessment of the minimum acceptable conditions that would prudently be allowed prior to capital improvements being undertaken. For this reason, all deficiency and investment requirement appraisals contained in this report represent an engineering perspective, rather than a purely economic

perspective, on the nature of highway conditions and capital requirements.

It should be noted that the HPMS analytical process, and the procedure similarly developed to assess bridge requirements, views the highway and bridge system as a capital asset, rather than as a consumer good. Both procedures are prospective in nature, emphasizing the long-term capabilities of the system, rather than the short-term requirements for satisfying only today's needs. Specifically, HPMS "looks ahead" when a deficiency is identified and an improvement type is selected, in order to take into consideration service requirements several years into the future. Capital improvements are simulated based on 20-year projections of traffic volume and volume-to-capacity ratios, while resurfacing improvements are only simulated if they will suffice for a minimum of six years.

In this manner, the system always has a residual service value. Other methods of needs estimation often view only the current system requirements, with the result that the system's present asset value is in a constant state of depreciation. Any investment strategy that fails to recognize the long-term implication of short-term decisionmaking will result, in time, in a depreciated capital asset value. Given the fact that approximately 20 percent of the Nation's GNP is expended for transportation, with the great majority of this on highways, a depreciated capital asset could have serious and long-term repercussions for economic growth and performance. The investment/performance process used by HPMS is designed to reflect the nature of the highway system as a capital asset, and the resulting investment requirements should be viewed within that context.

As each highway section is analyzed using the HPMS analytical process, the resulting physical and operating characteristics are compared each simulation year against the MCS's. If one or more minimum condition standards is not met during the simulated year's worth of highway usage and deterioration, the process notes a deficiency and simulates a suitable capital improvement to mitigate or remove the deficiency. The type of improvement simulated depends on the particular deficiency or combination of deficiencies noted, and the stage in the highway section's usable design life during which the deficiency occurs.

When a deficiency is identified and a suitable improvement simulated, the section's condition and performance indicators are

upgraded to reflect the improved condition. The improved condition is a function of the type of improvement simulated, and the condition of the segment when the improvement is simulated. A segment may have more than one improvement simulated over a 15-20 year analysis period.

Each improvement has an associated cost per lane-mile based on national cost estimates that have been modified to reflect variations in average State project costs. All dollar estimates are in 1987 dollars.

Investment/Performance Requirements for Highways Functionally Classified as Nonlocal

Constrained Full Needs Investment Strategy

The compilation of all deficiencies, including backlog and accruing future deficiencies, is the sum total of deficiencies that either currently exist or will develop at some point on the existing system through the year 2005. The cost of rectifying all of these deficiencies, where improvements can feasibly be made, is termed "constrained full needs" for the existing highway system.

Full needs does not imply system perfection. It means that no section of road would exhibit physical and operating characteristics that violate the minimum condition engineering standards used to identify deficiencies. This does not mean that the highway system would be without problems, however, since the minimum standards are significantly below full design standards for new roads. Although some problems would remain, none would be considered serious enough to warrant improvement under the minimum conditions standards assumed in the analysis.

Constrained full needs reflects only those capacity improvements that can reasonably be expected to be made, especially in congested urbanized areas where rights-of-way are at a premium. Since this condition is the rule rather than the exception in our most congested urbanized areas, operating characteristics may be expected to decline in urban areas, even under the constrained full needs scenario, simply because there is not enough physical space to accommodate the additional needed lanes of highway capacity or the cost would be prohibitive. The solution to urban peak-period congestion must be met, to the extent that it can be met, through a combination of traditional capacity additions and innovative

demand management/supply enhancement approaches. It is highly unlikely that urban areas, particularly the largest urban areas, will be able to build their way out of peak-period congestion.

Tables IV-5, 6, and 7 present constrained full needs estimates for the three travel scenarios, including total investments by type of improvement. These estimates reflect requirements only on existing highways functionally classified as nonlocal. No additional lane-miles of facility are simulated where such additions are currently considered infeasible because of insufficient or high cost right-of-ways. All structural (bridge) costs have been removed in order not to overlap with the bridge estimates that follow in this chapter.

The backlog of highway needs in 1987 is estimated to be approximately $155 billion. This is between 23 and 27 percent of total full constrained needs for the period 1987-2005. Backlog needs in urban areas are slightly higher than in rural areas, primarily because of the capacity backlog in urban areas. Among rural roads, the lower functional systems exhibit a slightly higher share of backlog needs, primarily because of pavement deficiencies.

Alternative Investment Strategies

In addition to the full needs strategy, the analytical process can be used to calculate costs associated with other strategies, using a cost-effectiveness calculation to establish the rank-order priority for eliminating deficiencies. For example, given less money than required under the full needs scenario, the analytical process may be used to select deficiencies weighted by the relative amount of travel carried or the length of the highway segment.

The algorithm may also be used to demonstrate the fiscal and system impacts of alternative program structures or program emphases, such as emphasis on pavements, as opposed to capacity improvements, or emphasis on arterials, as opposed to collector system investments. Use of this procedure provides estimates for achieving alternative definitions of systems performance. For the investment strategies described in the remainder of this chapter, all improvements have been prioritized based on the travel weighted cost-effectiveness of investment.

Maintain Overall 1985 Conditions Investment Strategy

One alternative investment strategy is the cost to maintain overall conditions on the existing highway system. This estimate,

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included in Table IV-8, represents the investment requirements to maintain an overall composite rating on highways, including a measure for service, safety, and condition. In general, this estimate provides for improvements in highway physical conditions but results in some deterioration in system performance on both the urban and rural portions of the Interstate System.

For the first time since the HPMS analytical process has been used for needs estimation, cost to maintain overall conditions on the Interstate System is higher than constrained full needs. The analytical process using the 1987 HPMS database suggests that it will not be possible to maintain overall Interstate conditions without adding some number of new lane-miles to accommodate anticipated demand. An estimated 11,000-15,000 additional lane-miles of facility, beyond what is currently considered feasible for capacity addition by today's standards, must be added to maintain the overall composite index of conditions and performance on both the rural and urban portions of the Interstate System. This is in addition to the lane-mile capacity additions that are simulated where such additions are considered feasible by current standards.

The portion of the 11,000-15,000 additional lane-miles attributable to the rural Interstate System would be marginal. Additions to the urban Interstate, however, would be more substantial, representing an increase of between 17 and 25 percent to the existing urban Interstate lane-miles.

The costs included in Table IV-8 do not include any costs for the additional lane-miles on the Interstate System. Since the addition of these lane-miles is currently considered to be infeasible because of right-of-way restrictions, the actual cost could be higher, possibly much higher, than the costs included on Table IV-8. This is because reliance on traditional new highway capacity within existing Interstate alignments might include such high cost items as cut and cover, tunneling, or double deck types of projects in lieu of traditional lane additions. Since the national experience in these types of projects is limited, and the costs per project so variable, it is difficult to estimate with any certainty the actual costs that would be suggested by the aggregate capacity additions.

It is also difficult to estimate whether traditional capacity improvements can be made at any cost within certain urban corridors. The State designation of feasibility ascribed to each HPMS sample section is a subjective determination, based on an

engineering judgment of the availability of rights-of-way and the construction costs associated with lane additions within that particular alignment. Future demand may force a reappraisal of the definition of feasibility. In some cases, traditional highway capacity improvements will be made, even in the face of higher than average costs-per-lane-mile. In other cases, the cost may be so extraordinary that the build alternative is no longer available.

In these cases, alternative solutions to the urban congestion problem must be considered. These may include, among other options, enhanced transit, innovative systems management, peak-period demand management, incident management, freeway surveillance and control, or toll facilities. In some cases, even with the adoption of innovative strategies, congestion may become permanently entrenched as a normal facet of urban life.

Under the "maintain overall 1985 conditions" scenario, because of the relative differences in the conditions of roads at the beginning of the analysis period, the distribution of investment by highway system is significantly different than the distribution under the constrained full needs scenario. Chapter III noted, for example, that the principal arterials are in much better condition, on average, than the collector systems. The cost to maintain overall 1985 conditions on the collector functional systems is, therefore, substantially lower compared to similar requirements on the principal arterials. Cost to maintain overall 1985 conditions is also relatively lower on the collectors than on the principal arterials compared to full constrained needs on either system.

The reader should be aware that the cost to maintain overall 1985 conditions scenario refers only to the overall conditions of the highway. This investment strategy will not maintain the actual cost of highway operations to users. These costs, including the cost of vehicle operation (fuel, oil, tires, depreciation, and vehicle maintenance) and the cost of traveltime can be expected to increase slightly above current levels under this strategy because of declining levels of service on higher functional systems in urbanized areas. This is particularly true when the value of traveltime is factored into the calculation of user cost.

The "maintain overall 1985 conditions" strategy is included here to provide continuity with previous editions of this report. The virtue of this investment scenario is that it describes the cost of maintaining an overall level of condition and performance, expressed in terms of a sufficiency-type composite indicator. The weakness of this method is that an overall composite indicator

tends to mask changes in the components of the indicator. Within the higher functional systems, for example, under the maintain overall 1985 conditions scenario, pavement conditions tend to improve while performance declines slightly. While the composite index remains essentially unchanged over time, the condition and service components of the composite index fluctuate.

This procedure tends to overstate rural and lower functional system investment requirements at the expense of urban areas and higher functional systems. The result is that overall user costs increase as urban and higher functional system travel occurs under slightly less advantageous conditions than does rural and lower systems travel. Since more travel occurs under the former and less under the latter, overall user cost increases.

Maintain Systems Performance Investment Strategy

In an effort to overcome the idiosyncrasies inherent in the cost to maintain overall conditions scenario, a different estimate is included in this version of the biennial report to simulate a more reasonable goal for capital investment. Where cost to maintain overall 1985 conditions reflects the cost of maintaining an overall composite rating, the maintain systems performance strategy focuses on identifying the predominant purpose that individual functional systems serve and the cost of sustaining effective delivery of that type of function through the year 2005.

For example, service and safety are the dominant performance characteristics of higher functional classes of highway, including the urban and rural Interstate, other urban expressways, and all principal arterials. For other facilities, a composite index of service, physical conditions, and safety attributes more accurately represents the dominant functional requirement. The cost to maintain system performance simulates the investment required to keep functional systems doing what they were designed to do, as well as they did them in 1985.

This estimate uses level of service, a measure of peak-period congestion, to simulate the service characteristic on higher class functional systems, both in urban and rural areas. Since the average level of service in most urbanized areas, and some rural areas, is well below that which would allow free flow of traffic, this estimate simply represents the cost of preventing further service deterioration. It does not imply any improvement in the average service level.

The cost to maintain system performance requires that substantial new capacity, on the order of from 11,250 to 25,000 additional lane-miles, be added in locations where it is not currently considered feasible to add new capacity due to right-of-way restrictions. (This is in addition to new capacity that is simulated where such capacity additions are considered feasible.) Such new capacity may take the form of added lanes on adjacent facilities, redesign of current Interstate or other types of higher class facilities, or new capacity on new rights-of-way.

The cost of maintaining system performance would result in a continuation of overall quality of highway condition, service, and safety on lower classes of highway, providing the needed accessibility to the higher classes of road. It would also provide sufficient capacity improvements to ensure that future traffic congestion, particularly in the larger urbanized areas, would not increase from those levels experienced by highway users in 1985.

Table IV-9 contains the costs to maintain system performance estimates. Costs associated with the additional 11,250-25,000 lane-miles are not included since they fall into the category of "infeasible" by today's standards. The discussion of these lane-miles parallels the previous discussion included under the cost to maintain overall 1985 conditions section. The only difference is in the extent. While overall 1985 conditions can be maintained on all of the higher functional systems in urban areas except for the Interstate, additional lane-miles, or their equivalent, must be added to the urban freeways and other principal arterials, as well as the urban Interstates, to maintain system performance.

The reader should note that the overall costs of either maintaining a composite index of conditions or maintaining system performance are virtually identical because of the exclusion of any costs associated with the added lane-miles discussed above. If costs were included, the cost of maintaining system performance would indicate higher rates of investment in urban areas compared to rural areas. It would also require greater investment in higher functional systems within urban areas compared to lower systems.

Investment Requirements for the Nation's Bridges

In past versions of this report, the investment requirements for bridges were taken directly from the congressionally required annual report on the status of the Highway Bridge Replacement and Rehabilitation Program (HBRRP). This report, referred to here as "the bridge report," is a program document that is concerned with

the implementation of a Federal program. It is not, and is not designed to be, an exhaustive and complete analysis of the Nation's entire bridge system.

As a program document, the bridge report includes information on current bridge conditions, changes in the condition status of bridges eligible for the HBRRP, and updated costs for replacing or rehabilitating currently deficient bridges.

The bridge report has proven to be an extremely useful program document, enabling highway decisionmakers to evaluate the effectiveness of program design and implementation, and providing a timely "pulse" on the magnitude and nature of current bridge problems. The National Bridge Inventory, the database used in the analysis that supports the bridge report, is certainly among the few, if not the only, comprehensive inventories of a major public works component available on a national basis.

The purpose of this report, however, is to describe total conditions and performance information and total investment requirements for highways and bridges. The coordination of bridge program information with highway investment requirements for the purposes of this report has demanded changes in the manner of assessing bridge investment requirements, in order to support comparability between highways and bridges. The most significant of these changes involved the development of a reproducible procedure for estimating accruing bridge investment requirements for all bridges, not only those currently eligible for the HBRRP.

Such a procedure has been developed, based on the concept of investment/performance, the same concept applied to the highway component of overall needs. The adoption of this procedure, detailed documentation of which appears as Part I, Appendix B of this report, for this and future reports will provide decisionmakers with an overall investment requirement that reflects both current and future anticipated needs.

Since the newly developed simulation procedure is in its infancy and is subject to review and minor revision, only the full needs scenario for bridges is included in this chapter and in the Introduction and Summary. After further work is done to refine the investment/performance relationships, alternative investment strategies similar to those described in the highway section of this chapter will be included.

Table IV-10 shows preliminary full bridge needs estimates by functional system for rural and urban bridges by type of improvement, backlog and accruing.

The reader should note that the annualized bridge needs, appearing in Table IV-10 in parentheses, are included for the sake of comparability with highway needs, and may not represent actual program levels that might be required to address specific bridge requirements.

It is not appropriate to compare bridge backlog deficiencies to highway backlog deficiencies. Highway deficiencies might result in increased vehicle operating costs and travel time, and discomfort to drivers and passengers. Bridge deficiencies, on the other hand, might represent a danger to public safety if the deficiency is not eliminated in a timely fashion. Deficient bridges may be load posted, as is currently the practice, to protect highway users and prolong the life of the structure until sufficient funds are available to address the need. In many cases, however, the deficiency must be addressed, particularly on the higher order highway systems, in order to ensure the safe, efficient, and unimpeded flow of commerce.

Bridge investment requirements are a function more of the age of the structure than any other single characteristic. Figures V-1 and 2 depict the distribution of structures and bridge deck area by age. These figures reflect the high level of Interstate System program activity that occurred throughout the 1960's and early 1970's. The bridge simulation procedure suggests that many of these Interstate bridges, in addition to other bridges, will require rehabilitation during the 1990's. The total capital requirement to address these accruing needs, as well as the requirement to reduce the backlog of bridge needs may result in several years of budget requirements that exceed the $4.9 billion shown in Table IV-10, if total bridge needs are to be addressed.

Table IV-11 summarizes highway and bridge investment requirements by functional system on both a total and an annualized basis. Note that bridge requirements are independent of highway investment level and travel forecasts.

Table IV-1

Trends in Vehicle Ownership, Use, and Licensing
1969-1983

Year	Vehicles per Household	Miles per Vehicle	Miles per Household	Adults with Drivers Licenses		
				Men	Women	All
1969	1.2	11,600	13,920	87.0%	61.2%	73.6%
1977	1.6	10,678	17,086	90.0%	74.0%	81.5%
1983	1.7	10,315	17,535	90.3%	77.6%	83.6%

Table IV-2

Estimates of Annual U.S. Vehicle-Miles of Travel

Year	Total Travel (millions)	Annual Percent Change
1960	718,762	2.61%
1961	737,421	2.60%
1962	766,734	3.98%
1963	805,249	5.02%
1964	846,298	5.10%
1965	887,812	4.91%
1966	925,899	4.29%
1967	964,005	4.12%
1968	1,015,869	5.38%
1969	1,061,791	4.52%
1970	1,109,724	4.51%
1971	1,178,811	6.23%
1972	1,259,786	6.87%
1973	1,313,110	4.23%
1974	1,280,544	-2.48%
1975	1,327,664	3.68%
1976	1,402,380	5.63%
1977	1,467,027	4.61%
1978	1,544,704	5.29%
1979	1,529,133	-1.01%
1980	1,527,295	-0.12%
1981	1,552,803	1.67%
1982	1,595,010	2.72%
1983	1,652,788	3.62%
1984	1,720,269	4.08%
1985	1,774,179	3.13%
1986	1,834,872	3.42%
1987	1,924,327	4.88%
1988 (est)	2,000,000	3.93%
1989 (proj)	2,075,000	3.75%
1990 (proj)	2,150,000	3.61%

TABLE IV-3
RURAL MINIMUM CONDITIONS STANDARDS (MCS)

	INTERSTATE			OTHER PRINCIPAL ARTERIALS						MINOR ARTERIALS						MAJOR AND MINOR COLLECTORS								
ADT	ALL ADT			6000			= 6000			2000			= 2000			1000			400-1000			LESS THAN 400		
Terrain	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Lane Width	12	12	12	11	11	11	11	11	11	10	10	10	10	10	10	10	10	10	8	8	8	16	16	16
Rshld Width	8	8	6	8	8	6	8	8	6	6	6	4	6	6	4	4	4	4	2	2	2	0	0	0
Shld Type	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
Pave Cond	3.0	3.0	3.0	3.0	3.0	3.0	2.8	2.8	2.8	2.4	2.4	2.4	2.4	2.4	2.4	2.0	2.0	2.0	2.0	2.0	2.0	1.8	1.8	1.8
Oper Speed	50	45	40	50	45	35	45	40	35	40	35	30	30	30	25	30	25	20	0	0	0	0	0	0
V/C Ratio	0.75	0.75	0.75	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	1.00	1.00	1.00	1.00	1.00	1.00
Surf Type	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	5	5	5
Hor Align	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
Ver Align	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3

Note: Terrain Types are Flat, Rolling and Mountainous.
MTC Shown for Lane Width on Collectors Group 4 are for Surface Width.
V/C Ratio MCS are used only for sections in densely developed areas where operating speed is not applicable.

Shoulder Type Codes:
1 - Surfaced
2 - Stabilized
3 - Earth
4 - Curbed

Surface Type Codes:
1 - High Flexible
2 - High Rigid
3 - Intermediate
4 - Low
5 - Gravel

Horizontal/Vertical Alignment Codes:
1 - All Curves/Grades Meet Design Standards.
2 - Some Curves/Grades Below Design Standards.
3 - Curves/Grades with Reduced Speed.
4 - Several Curves Unsafe/Significant Reduction of Speed on Grades

TABLE IV-4

URBAN MINIMUM CONDITIONS STANDARDS (MCS)

		Interstate	Other Freeways & Expressways	Other Principal Arterials	Minor Arterials	Collectors
Operating Speed:	Built-up	30	30	--	--	--
	Outlying	35	30	--	--	--
Volume-to-Capacity Ratio		0.90	0.90	0.90	0.95	0.95
Lane Width		12	11	10	8	8
Surface Type		2	2	2	3	4
Pavement Condition		3.2	3.0	2.8	2.4	2.0
Shoulder Type		1	1	2	3	3
Right Shoulder Width		8	8	6	6	6

Shoulder Type Codes:
1 - Surfaced
2 - Stabilized
3 - Earth
4 - Curbed

Surface Type Codes:
1 - High Flexible
2 - High Rigid
3 - Intermediate
4 - Low
5 - Gravel

TABLE IV-5

Estimated Capital Requirements by all Units of Government
to Remove all Deficiencies (Constrained Full Needs) through 2005
(Billions of 1987 Dollars)

	URBAN						RURAL						
VMT	Inter.	Other Freeways	Other Prin. Art.	Minor Arter.	Collec.	URBAN TOTAL	Inter.	Other Prin. Art.	Minor Arterials	Major Collec.	Minor Collec.	RURAL TOTAL	TOTAL
3.0%	73.80	33.79	103.59	97.23	54.72	363.13	42.54	51.52	53.90	90.13	54.54	292.62	655.75
2.34%	56.87	29.76	93.97	84.73	50.04	315.36	38.81	46.33	49.93	86.40	52.60	274.08	589.44
2.0%	53.83	27.95	89.93	82.06	48.95	302.72	34.75	42.45	48.25	86.07	51.04	262.56	565.28

TOTAL URBAN AND RURAL

VMT	Urban	Rural	TOTAL	Billions of Dollars/Year
3.0%	363.13	292.62	655.75	34.51
2.34%	315.36	274.08	589.44	31.02
2.0%	302.72	262.56	565.28	29.75

TABLE IV-6

Urban Highways (Constrained Full Needs, 1987-2005)
(Millions of 1987 Dollars)

Rate of Travel Growth (Percent per Year)	Interstate			Other Freeways and Expressways			Other Principal Arterials			Minor Arterials			Collectors			TOTAL		
	3.0	2.34	2.0	3.0	2.34	2.0	3.0	2.34	2.0	3.0	2.34	2.0	3.0	2.34	2.0	3.0	2.34	2.0
Reconstruction to Freeway Standards	111	106	106	1,936	1,557	1,430	0	0	0	0	0	0	0	0	0	2,046	1,664	1,536
Reconstruction with Added Lanes	5,676	3,594	3,041	1,668	1,224	873	5,750	3,715	3,905	2,619	1,560	1,852	812	679	1,149	16,525	10,771	10,821
Reconstruction with Wider Lanes	48	48	48	20	29	32	829	281	436	141	98	102	145	87	62	1,182	544	681
Pavement Reconstruction	1,679	1,748	1,798	385	442	558	3,416	3,599	3,483	4,170	4,577	4,542	1,891	1,820	1,812	11,540	12,186	12,192
Major Widening	38,006	28,749	26,297	18,933	15,492	13,856	48,273	38,523	34,334	47,390	36,013	33,611	17,155	12,809	11,273	169,757	131,586	119,372
Minor Widening	5,790	206	206	479	509	629	1,920	4,099	3,951	3,689	2,927	2,405	1,832	1,382	1,291	13,711	9,122	8,482
Resurfacing with Shoulder Improvements	461	463	466	1,548	1,592	1,614	5,609	5,857	5,948	7,918	8,167	8,202	11,727	11,864	11,947	27,264	27,944	28,178
Resurfacing	22,024	21,958	21,862	8,825	8,913	8,960	37,791	37,896	37,868	31,300	31,385	31,344	21,161	21,394	21,419	121,101	121,546	121,454
TOTAL	73,796	56,872	53,826	33,794	29,758	27,953	103,587	93,969	89,926	97,227	84,728	82,058	54,723	50,035	48,954	363,127	315,363	302,717

TABLE IV-7

Rural Highways (Constrained Full Needs, 1987-2005)
(Millions of 1987 Dollars)

Rate of Travel Growth (Percent per Year)	Interstate			Other Principal Arterials			Minor Arterials			Major Collectors			Minor Collectors			TOTAL		
	3.0	2.34	2.0	3.0	2.34	2.0	3.0	2.34	2.0	3.0	2.34	2.0	3.0	2.34	2.0	3.0	2.34	2.0
Reconstruction to Freeway Standards	25	18	18	14,800	11,574	8,060	0	0	0	0	0	0	0	0	0	14,824	11,593	8,078
Reconstruction with Added Lanes	1,757	1,480	1,379	1,387	1,037	977	3,814	2,188	2,126	1,637	1,404	939	156	97	65	8,751	6,205	5,486
Reconstruction with Wider Lanes	0	0	0	1,145	1,092	1,146	2,857	2,849	2,912	11,435	10,514	10,111	10,836	9,937	8,824	26,273	24,391	22,992
Pavement Reconstruction	896	1,020	987	2,068	2,113	2,116	2,380	2,235	2,275	28,875	28,111	28,940	21,303	20,905	21,018	55,442	54,384	55,336
Pavement Reconstruction with Alignment	57	57	57	363	350	353	963	940	956	9,408	9,597	9,599	5,652	5,605	5,481	16,443	16,548	16,426
Major Widening	20,972	17,660	13,817	5,705	3,959	3,287	7,811	5,294	3,596	3,829	2,808	2,519	548	491	205	38,866	30,173	25,424
Minor Widening	15	15	19	1,028	1,063	1,069	706	654	633	2,459	2,229	2,209	1,968	1,433	1,457	6,178	5,595	5,388
Resurfacing	18,127	17,851	17,766	12,888	12,896	13,031	10,587	10,751	10,774	11,480	11,670	11,860	6,153	6,267	6,366	59,235	59,436	59,797
Resurfacing with Shoulder or Alignment Improvement	690	705	707	12,153	12,248	12,410	24,859	25,024	25,000	21,006	20,867	19,893	7,919	7,709	7,622	66,607	65,753	65,632
TOTAL	42,539	38,806	34,751	51,518	46,333	42,449	53,897	49,955	48,252	90,130	86,399	86,070	54,535	52,604	51,038	292,619	274,076	262,559

TABLE IV-8

Estimated Capital Requirements by all Units of Government
to Maintain Overall 1985 Conditions, 1987-2005
(Billions of 1987 Dollars)

	URBAN							RURAL						
VMT	Inter.	Other Freeways	Other Prin. Art.	Minor Arter.	Collec.	URBAN TOTAL		Inter.	Other Prin. Art.	Minor Arterials	Major Collec.	Minor Collec.	RURAL TOTAL	TOTAL
3.0%	73.80	34.10	103.59	71.25	31.40	314.14		42.54	23.60	22.90	34.57	16.07	139.68	453.82
2.0%	53.84	27.95	90.09	60.68	28.08	260.64		34.76	18.81	20.50	33.21	15.11	122.39	383.03

TOTAL URBAN AND RURAL

VMT	Urban	Rural	TOTAL	Billions of Dollars/Year
3.0%	314.14	139.68	453.82	$23.89
2.0%	260.64	122.39	383.03	$20.16

TABLE IV-9

Estimated Capital Requirements by all Units of Government
to Maintain 1985 Levels of System Performance, 1987-2005
(Billions of 1987 Dollars)

	URBAN							RURAL						
VMT	Inter.	Other Freeways	Other Prin. Art.	Minor Arter.	Collec.	URBAN TOTAL		Inter.	Other Prin. Art.	Minor Arterials	Major Collec.	Minor Collec.	RURAL TOTAL	TOTAL
3.0%	73.84	33.79	103.59	71.25	31.40	313.87		42.54	22.80	22.89	34.57	16.07	138.87	452.74
2.0%	53.84	27.95	90.09	60.68	28.08	260.64		34.76	18.81	20.50	33.21	15.11	122.39	383.03

TOTAL URBAN AND RURAL

VMT	Urban	Rural	TOTAL	Billions of Dollars/Year
3.0%	313.87	138.87	452.74	23.83
2.0%	260.64	122.39	383.03	20.16

Table IV-10

Estimated Investment Requirements by all Units of Government to Eliminate all Existing and Accruing Bridge Deficiencies, 1987-2005

(millions of 1987 dollars)

	Rehabilitation	Widening	Replacement	Total Backlog	Total
Rural					
Interstate	3,458	676	2,079	2,994	6,213
Other Principal Arterials	2,556	930	3,200	4,388	6,686
Minor Arterials	1,507	1,419	4,046	5,460	6,971
Major Collectors	1,520	640	5,764	6,226	7,925
Minor Collectors	479	232	2,799	2,968	3,511
Local	978	610	10,599	11,014	12,188
Total Rural	$10,498	$4,507	$28,488	$33,051	$43,493
Urban					
Interstate	8,579	858	9,040	10,718	18,477
Other Freeways and Expwy.	2,647	464	3,702	4,341	6,812
Other Principal Arterials	3,665	881	8,150	9,461	12,696
Minor Arterials	1,334	737	4,144	4,866	6,215
Collectors	561	208	1,584	1,754	2,352
Local	486	243	2,159	2,370	2,887
Total Urban	17,270	3,391	28,778	$33,511	$49,439
TOTAL	$27,768	$7,898	$57,266	$66,562	$92,932

TABLE IV-11

Capital Investment Requirements by all Units of Government for the Existing Highway and Bridge Systems, 1987-2005

(Billions of 1987 Dollars)

Functional System	Cost to Maintain 1985 Overall Conditions (see note "a")		Cost to Maintain 1985 System Performance (see note "b")		Constrained (c) Full Needs	
VMT Growth Rate (%)	2.0	3.0	2.0	3.0	2.0	3.0
RURAL						
Interstate	34.4 (a)	42.5 (a)	34.8 (b)	42.5 (b)	34.8	42.5
Other Principal Arterials	18.8	23.6	18.8	22.8	42.5	51.5
Minor Arterials	20.5	22.9	20.5	22.9	48.3	53.9
Major Collectors	33.2	34.6	33.2	34.6	86.1	90.1
Minor Collectors	15.1	16.1	15.1	16.1	51.0	54.5
Subtotal	$122.4	$139.7	$122.4	$138.9	$262.7	$292.5
URBAN						
Interstate	53.8 (a)	73.8 (a)	53.8 (b)	73.8 (b)	53.8	73.8
Other Freeways & Expwy	28.0	34.1	28.0 (b)	33.8 (b)	28.0	33.8
Other Principal Arterials	90.1	103.6	90.1 (b)	103.5 (b)	89.9	103.6
Minor Arterials	60.7	71.3	60.7	71.3	82.1	97.2
Collectors	28.1	31.4	28.1	31.4	49.0	54.7
Subtotal	$260.7	$314.2	$260.7	$313.8	$302.8	$363.1
Total Highway	$383.1 (a)	$453.9 (a)	$383.1 (b)	$452.7 (b)	$565.5	$655.6
(average annual)	20.2	23.9	20.2	23.8	29.8	34.5
Total Bridge (d)	$92.9	$92.9	$92.9	$92.9	$92.9	$92.9
(average annual)	4.9	4.9	4.9	4.9	4.9	4.9
Total Highway & Bridge	$476.0 (a)	$546.8 (a)	$476.0 (b)	$545.6 (b)	$658.4	$748.5
(average annual)	$25.1 (a)	$28.8 (a)	$25.1 (b)	$28.7 (b)	$34.7	$39.4

(a) At this level of investment, overall conditions cannot be maintained on the Interstate System within existing rights-of-way. A shortfall of between 11,000 and 15,000 lane-miles of new capacity, or their equivalent, would be the result. Options to address this shortfall include new construction, systems operation improvements, toll facilities, peak-hour demand management, and transit.

(b) At this level of investment, system performance cannot be maintained on either the urban or rural portion of the Interstate System, the urban freeways and expressways, and the urban principal arterials, within existing rights-of-way. A shortfall of between 11,250 and 25,000 lane-miles of new capacity, or their equivalent, would be the result of these investment levels. Options to address this shortfall include new construction, systems operation improvements, toll facilities, peak-hour demand management, and transit.

(c) This investment strategy assumes that capacity improvements will be made only where rights-of-way are currently available. This would result in system performance improvements on the lower functional systems, but performance deterioration on the higher systems, especially in highly congested urbanized areas where rights-of-way are at a premium.

(d) Bridge needs are based on a 2.34% average annual growth in travel. These estimates could change under alternative travel scenarios or investment strategies. The investment levels under each scenario represent the full cost of eliminating all backlog and accruing deficiencies.

CHAPTER V
FEDERAL-AID SYSTEMS AND THE BRIDGE PROGRAM

The Federal-Aid Highway Interstate Systems and the Highway Bridge Replacement and Rehabilitation Program (HBRRP) are the primary mechanisms for providing Federal funds to States for highway improvements. While there are over 40 categorical areas (including 152 demonstration projects) of Federal funding eligibility within the Federal-aid highway program, the majority of funds are concentrated in seven program areas--Interstate (construction, substitution and 4-R),primary, secondary, urban, and bridge. These seven programs accounted for more than 90 percent of the total obligations of Federal-aid highway funds in FY 1987. The material presented in this chapter addresses only the Federal-aid systems and is organized to isolate the federally funded components of the functional systems described in previous chapters.

The Federal-aid highway systems consisted of 848,756 miles of highways in 1987 (see Table III-18, Chapter III). Identification of a road as part of the Federal-aid highway systems is the first action a State takes in making the facility eligible for Federal aid. The systems do not have statutory limits on designated mileage but the systems are limited in extent to the functional arterial and collector route. In 1987, the system mileage represented 21.9 percent of the total 3,874,026 public highway mileage in the United States. Most of the system mileage, 656,875 miles or 77 percent of the Federal-aid system, is in rural areas. The Federal-aid rural mileage represents 21 percent of total rural public mileage. In urban areas, the Federal-aid systems consist of 191,881 miles or 23 percent of all Federal-aid mileage and 27 percent of total urban public miles nationwide.

The Federal-aid system, while representing only 22 percent of all public road mileage, carries a disproportionate share of the travel. In 1987 the Federal-aid routes carried over 82 percent of total travel. Travel on the Federal-aid system increased by 10 percent from 1985 to a total of 1.569 trillion vehicle miles in 1987. Rural travel on the systems increased from 588 million vehicle miles in 1985 to 636 million vehicle miles in 1987 or a 8 percent increase. Travel on the rural Federal-aid systems represented 33 percent of total vehicle miles traveled in 1987 (see Table III-18, Chapter III).

Calculated on a per-mile-basis, annual vehicle miles of travel on the Federal-aid rural systems was 16.6 times higher than for rural nonsystem roads.

In urban areas, travel on the Federal-aid systems was 934 million vehicle miles or 49 percent of total travel in 1987. This represents an 11-percent increase in travel on Federal-aid highways in urban areas from 1985. Eighty two percent of all urban travel occurred on the Federal-aid system in 1987. Annual Federal-aid urban system travel on a per-mile-basis was 12.1 times higher than for nonsystem roads.

During 1986 and 1987, Federal and State government capital expenditures on the Federal-aid systems (not including right-of-way and engineering) totaled $32.6 billion, an increase of $4 billion from the previous 2-year analysis period 1984-1985. Expenditures by improvement type included $10,093 million (31 percent) for new construction; $4,741 million (14.5 percent) for reconstruction; $2,341 million (7.2 percent) for major widening; $8,391 million (25.7 percent) for 3R; $4,705 million (14.4 percent) for bridge; and $2,353 million (7.2 percent) for safety and other.

The Interstate System

The Interstate System consists of 44,328 miles of limited access arterial highways linking major population, industrial and defense centers. The Interstate System was designed to serve interstate commerce, national defense and international movements while providing interconnectivity by terminating at other Federal-aid primary and urban systems. The highest physical geometric standards are found on the Interstate System. Over 99 percent of the mileage has lane widths of 12 feet or more with over 98 percent of the mileage alignment meeting design standards for grade and curve safety at prevailing speed limits. The System comprises 5.2 percent of all Federal-aid mileage (or 1.1 percent of total public mileage) and carries 27 percent of the travel on the Federal-aid system (see Table III-18, Chapter III). Most of the mileage (75 percent) is located in rural areas and 41 percent of annual Interstate vehicle miles of travel occur there. In urban areas, where 25 percent of the Interstate mileage is located, 59 percent of the annual Interstate travel occurs. Of total urban travel on all public roads, 21 percent occurred on urban Interstate in 1987. From 1985 to 1987 Interstate vehicle miles of travel increased by 11 percent in rural areas and 13 percent in urban areas.

During 1986 and 1987 capital disbursements by Federal and State governments on the Interstate System totaled $12.2 billion with $4.5 billion being used for new construction and $2.9 billion for 3R work. The largest share of the Interstate disbursements (62 percent) was for urban Interstate improvements. Even with an increase in disbursements, pavement in poor condition, as measured by the pavement serviceability ratings of less than or equal to 2.5, increased in rural areas from 10.8 percent in 1985 to 11.6 percent in 1987. Generally in urban areas the portion of pavement in poor condition has stabilized at 10.8 percent in 1987 as compared to 11.1 percent in poor condition in 1985. This is after a low period in 1983 when 17.5 percent of the pavement was estimated in poor condition. Correspondingly, pavements in good to excellent condition (PSR of 2.6 to 5.0) declined slightly in rural areas and increased slightly in urban locations.

The cost to maintain system performance on the Interstate System through 2005, as shown in Table I-3, varies from $88.6 billion ($4.7 billion/year) to $116.4 billion ($6.1 billion/year). This does not include the cost-to-complete the Interstate System, estimated at $16.3 billion as of January 1, 1988. (These costs are understated with respect to additional capacity--see Chapter IV for discussion).

The Primary System

The original Federal-aid highway system, the primary system, dates to the Federal Highway Act of 1921. The Act required a system of interconnected roads, interstate in character to be designated by the States with mileage not to exceed 7 percent of the total State mileage (there are no longer statutory limits on mileage). Congress realigned the primary system in 1976 to better reflect the interstate function since many of the roads designated earlier no longer served that function. (The Interstate System was incorporated into the primary system as a subset when the Interstate was created in 1944. For purposes of analysis in this report, the Interstate System is examined separately and not included in the primary system discussion). The primary system generally consists of both urban and rural arterial routes serving interstate, regional and statewide travel. Today the primary routes represent 7 percent of the total public mileage in the country and 30 percent of the total Federal-aid mileage. The Federal-aid primary system consists of 258,120 miles of highway and is located predominately in rural areas (87 percent) with the remaining 13 percent in urban areas. It represents 99 percent of all rural arterial highways and 25 percent of all urban arterials.

Travel on the primary system has increased from 519 billion vehicle miles in 1985 to 558 billion vehicle miles in 1987 an increase of 8 percent. This represents 29 percent of total national travel. Since 1985 there was a 7 percent increase in travel on the rural primary and an 8-percent increase in urban travel on the system. In the prior analysis period 1984 and 1985 growth in travel on the system was only 3.2 percent in rural areas and 12.6 percent in urban areas. The rate of increase in travel on the system has more than doubled in rural areas and declined slightly in urban areas over the prior analysis period.

Pavement conditions on the primary system have improved slightly since 1985. Even though travel has increased in rural areas the percent of pavement in poor condition (a PSR of 2.0 or less) has declined in rural areas from 8.6 percent in 1985 to 6 percent in 1987. In urban areas the percent of poor primary pavement has declined from 6.8 percent in 1985 to 5.5 percent in 1987. Pavement in good to very good condition has increased only slightly over the same period.

Expenditures on the primary system by Federal and State governments (local funds are not included) totaled $12.9 billion for 1986 and 1987. This represents 39 percent of all disbursements on the Federal-aid systems for those years. Disbursements on the rural primary totaled over 51 percent of all disbursements on the Federal-aid systems and urban primary totaled 26 percent of all disbursements on the Federal-aid systems. The largest share of the expenditures were for 3R and new construction in both rural and urban areas.

The cost to maintain system performance on the Federal-aid primary system, as shown in Table I-3, will vary between $108.3 billion and $127.4 billion, or from $5.7 billion to $6.7 billion annually. (These costs are understated with respect to additional capacity--see Chapter IV for discussion).

The Urban System

The urban system was established by the Federal-Aid Highway Act of 1970 to address the transportation requirements of urban areas. The urban system serves major urban activity centers, and includes high traffic volume arterial and collector routes, including access roads to airports and other transportation terminals. Routes are selected by local and State officials to aid

intracity movements. The routes are interconnected to others on the urban system or other Federal-aid routes. No route on the urban system is on another Federal-aid system.

The statutory Federal share of urban system projects is 75 percent except in States with large areas of public lands where the Federal share may be higher. Funds are apportioned to the States based on urban area population relative to nationwide urban population with the condition that the States must provide, through a fair and equitable formula, for urbanized areas of 200,000 or more population. Further, no State receives less than one-half percent of the total funds. During 1986 and 1987 State and Federal governments disbursed $4.8 billion (an increase of almost $1 billion from the prior analysis period 1984 and 1985) for urban system improvements with the largest share being used for new construction, 3R, and bridge improvements.

The urban system in 1987 consisted of 147,979 miles of highway classified functionally as other freeway or expressways (759 miles), other principal arterials (24,789 miles), minor arterials (66,302 miles), and collectors (56,129 miles). Arterials are the predominate highway type in the urban system.

During 1986 and 1987, travel on the urban system increased by 12 percent from 383 billion vehicle miles to 428 billion vehicle miles. While the system represents only 3.8 percent of total public mileage, it carried 22.2 percent of total vehicle miles traveled in 1987. The density of travel on the system, as measured by the daily vehicle miles of travel per mile of road, has increased by 8.4 percent since 1985, from 7,279 daily vehicle miles of travel per mile to 7,922. This is 7 times higher than the density of travel on off-system urban roads.

Conditions on the urban system have improved slightly since 1985. While the amount of pavement in good to very good condition declined slightly, the amount of pavement in poor condition declined. More pavement is now in fair condition than in 1985.

The cost to maintain overall 1985 conditions on the urban system, as shown in Table I-2, will vary from $121.3 to $140.3 billion or from $6.4 to $7.4 billion annually.

The Secondary System

Established in 1944, the secondary program originally was conceived to meet farm-to-market needs, but because of the broad

eligibility criteria used, it became a mixture of facilities from local access roads to high order arterials. Realigned by congressional mandate in 1976, the system now consists of rural major collector routes. The road system today consists of 398,329 miles of major collectors that comprise 47 percent of the total Federal-aid mileage. The roads, while not forming an interconnected network, provide: collector service to the rest of the Federal-aid system: intracounty interconnectivity; service to county seats and other large traffic generators not on the primary system; service to intracounty traffic corridors; and connections to higher order systems. While the system makes up 10.3 percent of total public mileage it carries less than 8.6 percent of total travel in 1987 (see Table III-18, Chapter III). Typically, the secondary road is a 2-lane rural road paved with an intermediate type of surface and not designed to carry heavy axle loads. In 1987, 11 percent of the pavement on the secondary system was rated in poor condition (with a PSR rating of 2.0 or less). This is a slight improvement since 1985 when 12.8 percent of the pavement was rated in poor condition. The system has a higher level of geometric deficiencies, e.g., narrow lanes and inadequate horizontal and vertical alignment, than any other Federal-aid system. For example, 27.4 percent are deficient with regard to horizontal adequacy and 20.9 percent have a vertical inadequacy. Fourteen percent of the system has lane widths of 9 feet or less. This is a slight improvement in lane width since 1985 when 16 percent of the system had the same impairment. (Lane width design standards for rural major collectors, established to improve safety, vary from 10 to 11 feet depending on traffic volumes.)

Travel on the system rose from 156 billion vehicles miles in 1985 to 166 vehicle miles in 1987, an increase of 6.4 percent. Travel density, while the lowest of any Federal-aid system, rose sightly from 1985 to 1,144 daily vehicle miles of travel per mile in 1987.

State and local governments disbursed $2.7 billion for capital improvements on the secondary system during 1986 and 1987. The majority of the money was used for 3R work (37.7 percent), bridges (19.9 percent) and new construction (18.2 percent).

The cost to maintain overall 1985 conditions on the secondary system, as shown in Table I-2, will range from $30.4 to $31.7 billion, or from $1.6 to $1.7 billion annually.

The Bridge Program

In recognition of the declining condition of the Nation's bridges the bridge program was established in 1970 under the Special Bridge Replacement Program. This program was superceded in 1978 with the Highway Bridge Replacement and Rehabilitation Program (HBRRP) and modified under the Surface Transportation Assistance Act (STAA) of 1982 and the Surface Transportation and Uniform Relocation Assistance Act (STURAA) of 1987. Since its inception the HBRRP has been used to fund improvements to 28,714 bridges. From fiscal year 1979 through fiscal year 1987, the States obligated a total of $11.26 billion of HBRRP funds. The maximum Federal share under the HBRRP is 80 percent of eligible project costs. The States obligated an additional $1.05 billion during the first three quarters of FY 1988 for a total of $12.3 billion since 1979. The States, using HBRRP funds during the period of calendar year 1987 and the first three quarters of 1988, improved 4,164 bridges. Further, the States spent $7.5 billion of other Federal-aid funds for bridge replacement or rehabilitation projects for fiscal year 1979 through June 1988. (Funds where used only for bridge improvements.)

Generally, eligibility for the bridge program is determined by a bridge sufficiency rating. (For further details on bridge eligibility and the bridge program see Part II of this report). The sufficiency rating is a composite of three major areas that are weighted as follows:

55 percent--structural adequacy and safety
30 percent--serviceability and functional obsolescence
15 percent--essentiality for public use

The lower the sufficiency rating, the higher the priority for replacement or rehabilitation. To be eligible for funding, the bridge must have a rating of 80 or less. All bridges with this rating are eligible for rehabilitation. If a bridge has a sufficiency rating less than 50 it is also eligible for replacement. All bridges identified as deficient under the bridge program will have a sufficiency rating of 80 or below.

Two categories are used to describe bridge deficiencies, either structurally deficient or functionally obsolete. Under the bridge program a structurally deficient bridge, as defined by FHWA, is one that (1) has been restricted to light vehicles only, (2) is closed, or (3) requires immediate rehabilitation to remain open. A functionally obsolete bridge is one on which the deck geometry,

load capacity (the comparison of the original design load to the current State legal load), clearance, or approach roadway alignment no longer meets the usual criteria for the system of which it is an integral part. A bridge, if classified as deficient does not imply that its collapse is imminent or that it is unsafe. Structurally deficient bridges can continue to serve traffic if load posted and restricted to posted maximum loads. Functionally obsolete bridges have geometric deficiencies that can be mitigated (but not eliminated) by the use of roadway striping, signs, signals and crash cushions.

It is important to note that bridges inventoried here as being deficient are also categorized as having a sufficiency rating of 80 or less and eligible for Federal aid. It is possible that a bridge could have a deficiency and not be eligible for the program because of a high overall sufficiency rating. Consequently not all bridges with a deficiency are inventoried here, only those eligible under the program guidelines (approximately 15,700 deficient bridges are not eligible for the program because their sufficiency ratings are above 80). These figures differ from the ones described in Chapter IV of this report where the universe of deficient bridges are analyzed and described, regardless of sufficiency rating. Of the 577,710 inventoried and classified bridges on and off the Federal-aid system as of June 1988, 238,357 are deficient (and eligible under HBRRP), declining from 243,646 in December 1986. The decline in total deficient bridges was not universal among Federal-aid and off-system bridges. The number of deficient bridges declined on the off-system by 5,618 but increased by 329 on the Federal-aid system for a net decline of 5,289 or 2.2 percent. Since 1982 the total number of deficient bridges has declined by 6 percent as described in Table V-1.

The estimated cost of bringing all deficient bridges, eligible for Federal-aid under the bridge program guidelines, up to current standards is $50.7 billion, a decrease of 1.4 percent from the previous report. This decrease is primarily the result of a decline in the number of deficient, eligible bridges. Ongoing bridge replacement, rehabilitation, removal and system realignment also contributed to the decrease. Bridge replacement and rehabilitation costs are derived using an average cost per bridge for each highway system calculated from cost estimates submitted by the States. In estimating costs, it is assumed that bridges with a sufficiency rating less than 50 will be replaced and bridges with ratings between 50 and 80 will be rehabilitated. These sufficiency rating thresholds are in keeping with current State bridge programming practices.

Using bridge cost estimates the States submitted to the National Bridge Inventory (NBI), a nationwide average cost per bridge for each highway system is calculated and aggregated for the Nation as shown in Table V-2. The costs shown in the table are for replacing and rehabilitating the HBRRP eligible deficient bridges to meet current standards. This is the traditional method of estimating bridge program costs.

Presently under the HBRRP the cost estimate to replace or rehabilitate all eligible deficient bridges has remained relatively stable over the past several years. This stable condition is not expected to change significantly over the short-term assuming current funding levels are maintained. In the long-term bridge needs are expected to increase. The growth in bridge needs is a result of the highway construction of the 1950's and 1960's. Bridge construction during this 20-year period accounts for approximately 40 percent of the deck area of all bridges in service today. On the Federal-aid system alone, over 1 billion square feet of bridge decks are now 15 to 35 years old. Figures V-1 and V-2 depict the growth in both the number of bridges and the deck area on and off the Federal-aid system.

The use of protective systems on bridge decks as a preventive maintenance measure was not standard practice in most States before the mid-1970's. Under average conditions in areas exposed to deicing salts, bridge decks built without corrosion protection for reinforcing steel can be expected to last 30 to 40 years before replacement or major rehabilitation is required. In severe environments, where traffic or winter salt applications are heavy, bridge decks often experience shorter life. As the large number of newer bridges advance in age another 5 to 10 years, a sharp increase in bridge rehabilitation and maintenance needs can be expected.

The estimates of bridge deficiencies and costs discussed above differ substantially from the bridge needs described in Chapter IV ($93 billion over the 19-year analysis period). The difference is attributable to a new analysis procedure for estimating both accruing and backlog needs and the inclusion of the universe of bridges under the new analysis (rather than just those eligible for Federal aid under bridge program guidelines). This new analysis procedure is explained in full detail in Appendix B of Part 1. As shown in Table V-3, the estimated cost of eliminating all existing and accruing Federal-aid bridge deficiencies is $93 billion using the new analysis method. Of the total $93 billion, $67.6 billion is needed to eliminate backlog/existing deficiencies and the

remaining $25.3 billion is necessary for accruing needs to the year 2005. Seventy seven percent (or $71.9 billion) of the total investment is attributable to the Federal-aid system bridges and the remaining 23 percent (or $20.9 billion) is needed for the off-system bridges. Over 60 percent of the investment requirements are needed for bridge replacement.

Future versions of both this report and bridge program analysis reports will rely on the needs assessment methodology described in Chapter IV in this report. The procedures used to calculate bridge investment requirements in previous HBRRP reports will be discontinued.

TABLE V-1
CHANGES IN THE NUMBER OF DEFICIENT BRIDGES

DATE	FEDERAL-AID SYSTEMS			OFF-SYSTEM			
	Structurally Deficient	Functionally Obsolete	Total	Structurally Deficient	Functionally Obsolete	Total	Grand Total
December 1982	28,070	41,575	69,645	104,084	79,467	183,551	253,196
December 1983	30,996	43,253	74,249	105,351	80,706	186,057	260,306
December 1984	33,389	41,809	75,198	107,419	77,558	184,977	260,175
December 1985	35,433	40,499	75,932	100,303	67,682	167,985	243,917
December 1986	36,321	40,542	76,863	95,241	71,542	166,783	243,646
June 1988	37,300	39,892	77,192	98,526	62,639	161,165	238,357

Source: Federal Highway Administration, Bridge Management Division

TABLE V-2

ESTIMATED COST OF REPLACING OR REHABILITATING CURRENTLY DEFICIENT BRIDGES ELIGIBLE FOR THE HBRRP INCLUDING FEDERAL AND STATE SHARES

(in billions of dollars)

System	Bridges Eligible for Replacement or Rehabilitation (sufficiency rating < 50)	Estimated Replacement Cost	Bridges Eligible for Rehabilitation (sufficiency rating 50-80)	Estimated Rehabilitation Cost	Total Cost
Interstate	811	1.0	4,238	2.5	3.5
Primary	8,324	8.2	13,379	5.3	13.5
Secondary	13,538	4.7	14,295	2.1	6.8
Urban	4,657	5.1	5,423	2.2	7.3
Total Federal aid	27,330	$19.0	37,335	$12.1	$31.1
Off-system	102,949	15.8	48,136	3.8	19.6
Total	130,279	$34.8	85,471	$15.9	$50.7

Interstate bridge needs are also eligible for funding under the Interstate Resurfacing, Restoration, Rehabilitation and Reconstruction Program.

TABLE V-3

ESTIMATED INVESTMENT REQUIREMENTS BY ALL UNITS OF GOVERNMENT TO ELIMINATE ALL EXISTING AND ACCRUING FEDERAL-AID SYSTEM BRIDGE DEFICIENCIES, 1987-2005

(millions of 1987 dollars)

Federal aid System	Rehabilitation	Widening	Replacement	Total	Total Accruing	Total Backlog	Total
Interstate	12,082	1,521	11,031	24,633	11,033	13,600	24,633
Primary	8,564	3,154	15,058	26,777	7,895	18,882	26,777
Secondary	1,467	670	5,334	7,471	1,635	5,836	7,471
Urban	3,299	1,351	8,416	13,067	3,173	9,894	13,067
Total Federal aid	$25,412	$6,696	$39,839	$71,947	$23,736	$48,211	$71,947
Off-System	2,195	1,215	17,575	20,985	1,605	19,380	20,985
TOTAL	$27,607	$7,911	$57,414	$92,932	$25,341	$67,591	$92,932

Figure V-1

NUMBER OF BRIDGES CONSTRUCTED BY FIVE-YEAR PERIOD

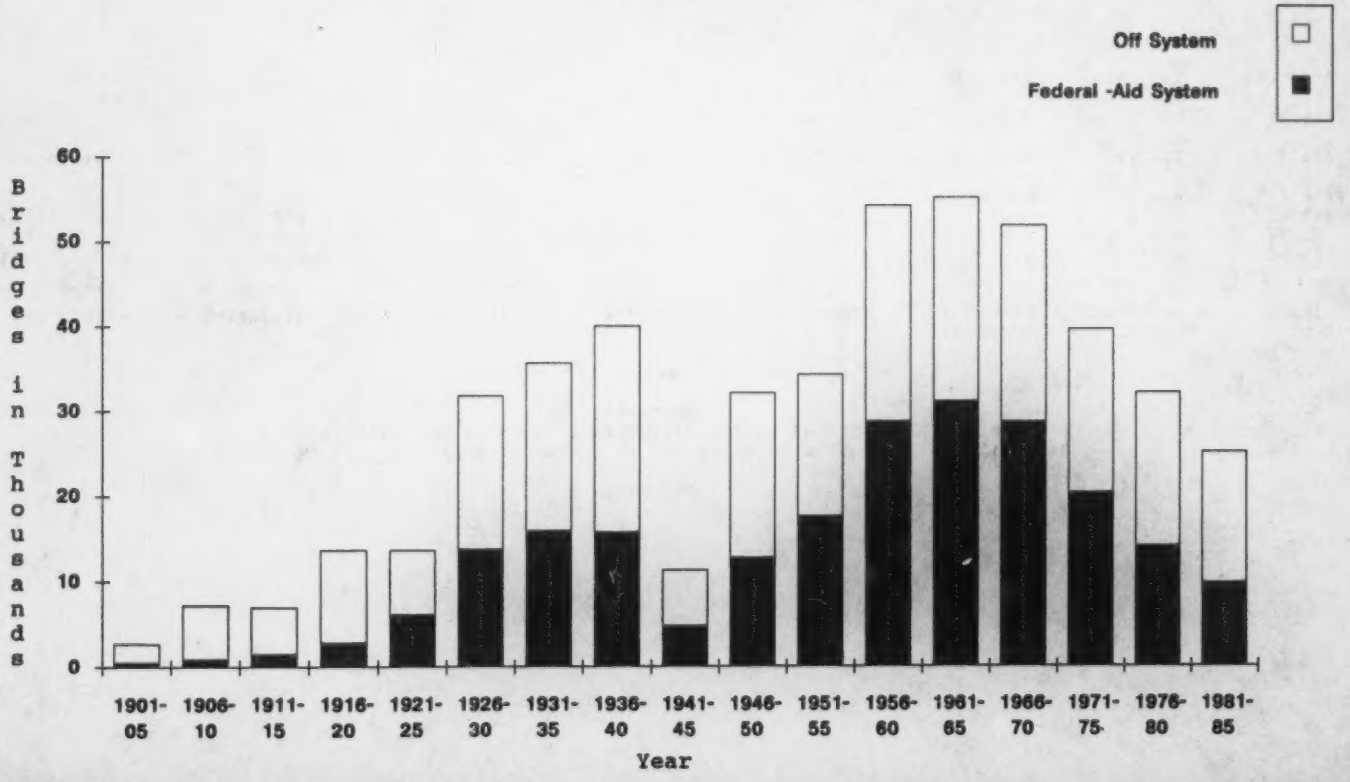
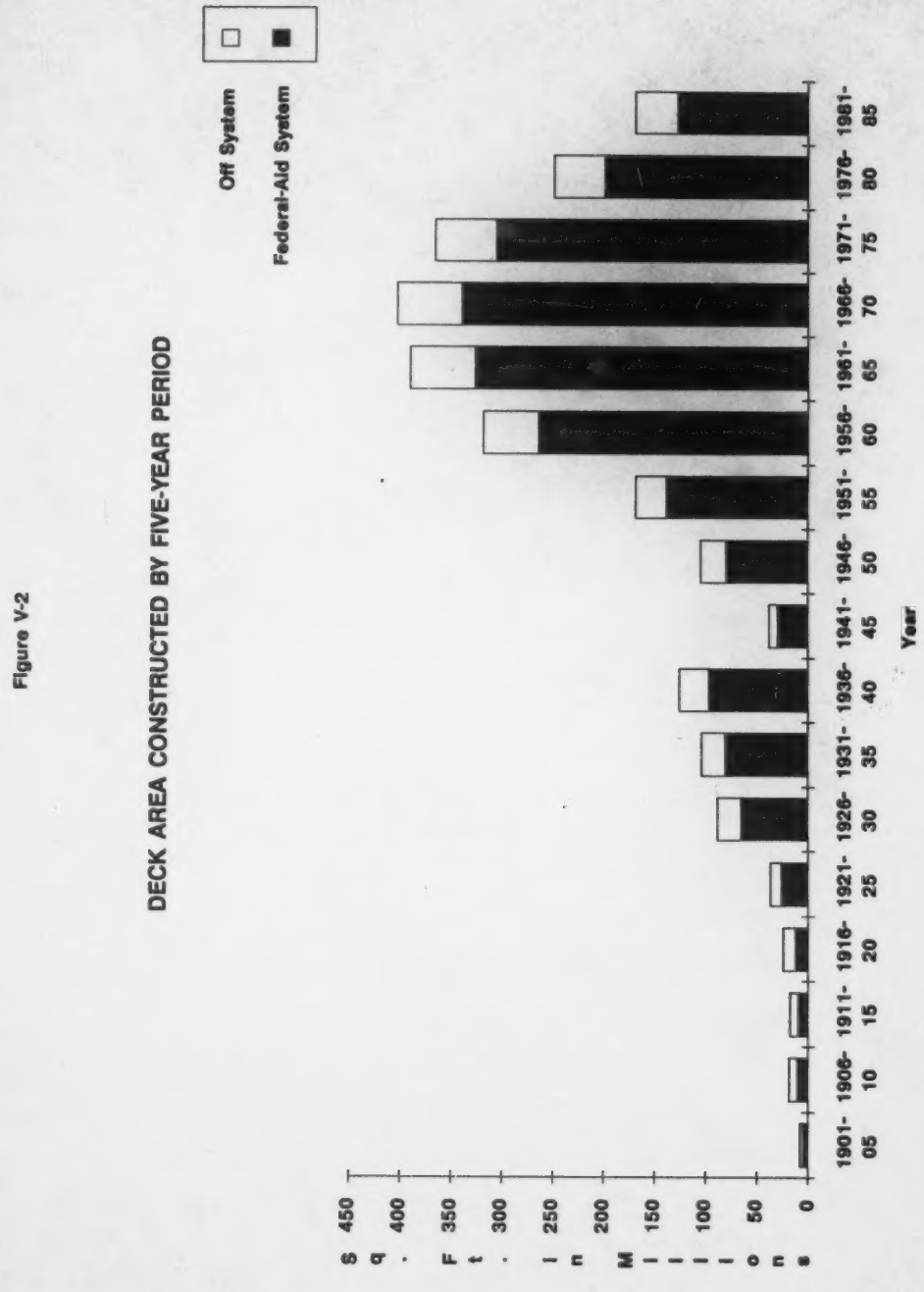


Figure V-2



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PART I

APPENDIX A

TABLE A-1

1987 AND 2005 TRAVEL FORECASTS
(THOUSANDS OF DAILY VMT)

STATE	1987	LOW* 2005 (2.0%)	MED** 2005 (-2.34%)	HIGH* 2005 (3.0%)
Alabama	83,397	130,371	110,041	155,399
Alaska	7,996	16,835	12,926	20,067
Arizona	N/A	N/A	N/A	N/A
Arkansas	47,958	64,931	83,025	77,396
California	577,022	800,929	851,078	954,687
Colorado	62,185	111,890	96,829	133,370
Connecticut	59,562	82,554	79,450	98,403
Delaware	14,155	18,683	16,280	22,270
Dist. of Col.	8,360	10,383	9,794	12,377
Florida	215,402	374,261	384,815	446,109
Georgia	145,687	217,193	259,115	258,888
Hawaii	14,783	25,649	19,015	30,573
Idaho	18,300	30,636	26,045	36,517
Illinois	184,062	233,301	235,552	278,089
Indiana	N/A	N/A	N/A	N/A
Iowa	51,394	69,581	71,397	82,939
Kansas	49,113	69,824	61,553	83,228
Kentucky	72,989	100,669	123,724	119,995
Louisiana	N/A	N/A	N/A	N/A
Maine	26,606	31,011	33,392	36,965
Maryland	92,185	113,210	150,819	134,943
Massachusetts	101,463	145,306	150,901	173,201
Michigan	191,753	220,407	269,748	262,720
Minnesota	82,800	122,278	111,817	145,753
Mississippi	45,610	72,389	68,803	86,285
Missouri	103,115	136,956	144,497	163,248
Montana	17,383	26,966	26,664	32,143
Nebraska	30,692	43,789	43,607	52,195
Nevada	21,313	34,226	30,920	40,797
New Hampshire	22,993	30,453	33,776	36,299
New Jersey	126,540	188,554	192,554	224,751
New Mexico	N/A	N/A	N/A	N/A
New York	239,754	295,104	345,003	351,756
North Carolina	122,526	190,021	249,147	226,501
North Dakota	12,773	20,082	20,361	23,937
Ohio	175,960	251,456	240,307	299,729
Oklahoma	N/A	N/A	N/A	N/A
Oregon	59,512	84,427	85,215	100,635
Pennsylvania	186,157	247,181	237,714	294,633
Rhode Island	12,514	21,026	14,298	25,062
South Carolina	74,749	105,367	125,695	125,594
South Dakota	14,953	22,639	20,409	26,986
Tennessee	101,210	136,996	155,107	163,295
Texas	338,201	559,567	618,873	666,990
Utah	29,473	55,079	44,932	65,653
Vermont	N/A	N/A	N/A	N/A
Virginia	128,964	174,493	181,364	207,992
Washington	100,042	137,617	154,174	164,035
West Virginia	34,766	42,739	50,962	50,943
Wisconsin	93,320	127,846	126,997	152,389
Wyoming	13,656	22,822	25,107	27,204
Total	4,213,348	6,017,698	6,393,802	7,172,943

*FHWA forecasts. Growth rates applied to total 1987 travel and distributed to the states using FHWA factors.

**State forecasts.

PART I

APPENDIX B

BRIDGE ANALYTICAL PROCESS

CHAPTER I. -- INTRODUCTION

NEED FOR THE BRIDGE ANALYTICAL PROCESS

The capability to assess the physical condition, safety, and efficiency of operation of the nation's bridges is important for the proper management of the highway systems of which the bridges are a crucial part. It is important for decision makers to know the current and projected conditions of the bridges under their purview, and to have access to estimates of the results of a range of capital investment strategies. Assessment of the effects of various funding levels over time is critical to the efficient use of available resources.

For several years the Highway Performance Monitoring System (HPMS) has been available at the national and State levels to provide estimates of current and future highway needs and the results of funding or improvement strategies for highway systems. However, this process does not specifically address bridge needs. The Bridge Analytical Process described herein is a move toward filling that void.

The National Bridge Inventory contains data furnished by the States for each bridge in the country with a length of 20 feet or greater. These data are furnished to the Federal Highway Administration (FHWA) in accordance with the requirements of the Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (hereinafter called the SI&A Guide). The Bridge Analytical Process utilizes these data for the analyses described herein.

PURPOSE AND SCOPE OF THE ANALYTICAL PROCESS

The Bridge Analytical Process has been developed to estimate the current and future needs of the nation's bridges. This process will estimate bridge needs that currently exist and that can be expected to accrue during a specified analysis period. Information regarding needs is necessary to determine the investment levels that will be required to maintain the nation's bridges at an acceptable level of service. The process will also provide estimates of the average condition of bridges resulting from proposed funding strategies. This will help to determine the overall condition trends under any particular funding scenario.

The data from the National Bridge Inventory (NBI) is used as the input to this analytical process. These data are furnished by each State to the Federal Highway Administration (FHWA), and updating is required biennially for each bridge in the nation. This data set includes inventory data on each structure, including an appraisal of the condition of the structure, and of the level of service that the bridge can provide for current traffic. All structures with a centerline length of 20 feet or greater are analyzed, including culverts.

ANALYSIS OVERVIEW

There are two types of analysis that can be done by the Bridge Analytical Process. These are the needs analysis and the investment analysis. The needs analysis identifies the deficiencies, selects improvements to correct these deficiencies, and estimates the costs of these improvements. The investment analysis is based on the needs analysis, but provides for the input of specific levels of investment for a specified analysis period. The results

of this level of investment are provided in terms of average bridge conditions and numbers of deficient bridges remaining.

Needs Analysis

The process analyzes each bridge record individually. Each record is analyzed by proceeding through a number of steps to determine whether the structure requires improvement to maintain its utility. The basic steps are as follows:

Determine the deficiency category: This step places each bridge in one of three categories shown below. The category is based on the structural and functional adequacy of the bridge. The determination is based on comparison of specified data elements with minimum tolerable condition (MTC) values. The remaining analytical procedures depend on the deficiency category.

> Structurally deficient: A bridge in this category is not structurally adequate. Load carrying capacity is the critical element in this determination.
>
> Functionally deficient: A bridge in this category is not adequate to serve fully its intended purpose. It may be deficient in bridge roadway width, vertical clearance, waterway, roadway alignment, or safe load capacity. Buried culverts are not analyzed for deck or bridge roadway width.
>
> Functionally adequate: Each structure not placed into one of the above two categories is placed in this category. The conditions of the structure are then compared to the minimum tolerable conditions to determine whether the bridge condition is deficient.

Determine deficiencies: Deficiencies are determined based on comparison with the values of the minimum tolerable conditions (MTC). Each structure classified as functionally adequate is tested against the appropriate MTC values. If any one of the minimum tolerable conditions is not met, the bridge is deficient.

Select improvements: An improvement is selected to correct the identified deficiencies. The selected improvement is either replacement of the complete structure, widening of the deck, or some type of rehabilitation. Rehabilitation may cover any type of improvement other than widening or replacing the entire structure. It may consist of rehabilitation of certain bridge components and/or may include replacement of certain components. The major components considered in the analysis are deck, superstructure, and substructure. When bridge widening is selected, rehabilitation may be included as needed.

Estimate cost of improvements: Costs of the improvement selected are based on the type of improvement, which may be replacement, widening, or rehabilitation. Improvement costs are available by State and Federal-aid System.

Deterioration over time: When a future analysis is specified, the conditions of the major bridge components are deteriorated over time and a traffic growth factor is applied. Needs and condition of the bridges at the end of the analysis period, by Federal-Aid System or functional class, are part of the output.

While the change in traffic volumes over time is used in determining bridge roadway width, there is no attempt made to analyze the capacity of the bridge geometry to accommodate the volume of traffic in a traffic capacity sense. This capability will await a linking of Bridge Analytical Process with the HPMS Analytical Process which analyzed highway sections contained in the HPMS sample section data.

Summarize results of the analysis: The number of deficient bridges and the funding level to correct all of the identified deficiencies is shown. These results are tabulated by either Federal-aid system or functional system. The number and costs of improvements by replacement, widening, and rehabilitation are shown.

Investment Analysis

The investment analysis builds upon the results of the needs analysis. It allows the user to specify a level of investment to be used for designated funding periods. The results of the specified levels of investment on the bridges are provided.

Ranking procedure: When the input level of investment is not sufficient to cover all selected bridge improvements, a ranking procedure is used to determine which improvements will be funded. Sufficiency rating, deficiency category, functional class, AADT, detour length and bridge posting are used in this procedure.

Simulate improvements that are funded: The bridge record is changed to reflect the changes to the bridge data elements resulting from the selected improvement. This may include changes in the condition or appraisal rating, bridge width or length, vertical clearance, or other elements. To provide time for an improvement to be accomplished, the deterioration process for an improved structure is delayed a year following the year the improvement is funded.

Summarize results of the analysis: The number of deficient bridges and the funding level to correct all of the identified deficiencies is shown. The results include the aggregated condition of the structures, which may be compared with base year conditions. The number of deficient bridges are summarized, along with an indication of the major reason for certain deficiencies.

DEFINITIONS

Bridge -- A structure carrying a highway or street over an obstacle such as another highway, railroad, or waterway. For inclusion in this analysis, the bridge is at least 20 feet long along the centerline of the highway. In this manual, the term bridge may include culvert, where not specifically identified separately.

Culvert -- A structure coded as a culvert in the NBI.

Buried Culvert -- A structure coded as a culvert but either deck width or bridge roadway width is not coded. It is assumed that the culvert is buried under some depth of fill.

Structure -- Synonymous with bridge, above.

Needs -- Needs are the amount of funding necessary to accomplish all selected improvements. Full needs funding will correct all identified deficiencies.

Backlog Needs -- Needs that exist in the inventory year before any deterioration or traffic growth are applied are called backlog needs.

Accruing Needs -- Accruing needs are those needs that are projected to occur at some time during the analysis period, following the inventory year.

Major Bridge Component -- The major bridge components as defined in this manual are the deck, the superstructure, and the substructure. The conditions of these components are important to the identification of deficiencies and the simulation of improvements.

Minimum Tolerable Conditions -- The minimum tolerable conditions (MTC) are values specified for specific data elements of the NBI that rate the condition of the major bridge components. These values are those determined to be the threshold level at which a deficiency is identified. A bridge with one or more values that do not meet the MTC values is deficient.

The MTCs are usually less than the design standards described below. They represent conditions that, while not ideal, are acceptable for use by the existing traffic loading.

Design Standards -- Design standards are the values for specified bridge data elements that are desirable for the particular class of bridge. New bridges will generally be designed to meet all applicable design standards. However, it is not generally economical to upgrade all existing bridges to these standards. In this Bridge Analytical Process, all bridges that are replaced will be improved to the applicable design standards. Widened bridges will meet design standards for bridge roadway width. Bridges that are rehabilitated may not meet any design standards, but will meet all minimum tolerable conditions.

If a bridge is structurally deficient, the only type of improvement selected is replacement. If a bridge is functionally deficient, either widening or rehabilitation is selected. Widening will be selected if it is considered feasible and if widening will correct the deficiencies. If a bridge is functionally adequate, rehabilitation may be needed.

DATA REQUIREMENTS

All bridge data used by the bridge needs model are taken from the NBI data set as described by the SI&A Guide. Also, certain factors are added to provide for prediction of future deficiencies. These include the deterioration equations, traffic growth rates, and K factors.

The deterioration equations developed by the Transportation Center are discussed in Chapter II.

Traffic growth factors were calculated using the HPMS sample section data, by State and by functional class. The K factors, for calculating the design hour volume from the ADT, were also calculated using the HPMS data by State and functional class.

The data set used by the FHWA as input to the bridge needs model is taken from the National Bridge Inventory data set. Since the year of inspection for each bridge may be any year within the last two years, the adjustments are made to certain data elements so they will be representative of a single base year. These elements are AADT, the inventory rating, and the condition ratings for deck, superstructure, and substructure.

ANALYSIS RESULTS

Output tables containing the results of the bridge needs model include the numbers of deficient bridges by deficiency category, with an indication of which data elements caused the deficiency. The averaged condition of the deck, superstructure, and substructure, for bridges and the condition of culverts are also listed.

There is a tabulation of the number of bridges needing improvement and the costs of these improvements. This tabulation is by rehabilitation, widening, replacement, and total, and can be by either by Federal-aid system or by functional class.

CHAPTER II. -- ANALYSIS PROCESS

INTRODUCTION

The Bridge Analytical Process has been developed to estimate bridge needs, both backlog and accruing, and to estimate the results of specified levels of investment. This chapter is a description of that process. To accomplish this analysis, each structure in the file is examined and a determination is made whether the structure is deficient. An improvement is selected to correct each identified deficiency, and the costs of the improvement is estimated. The improvement is simulated by upgrading the data elements affected by the improvement. The major steps of the process are described below.

All item numbers shown are from the Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (January 1979), hereinafter called the SI&A Guide. All data is available on the National Bridge Inventory (NBI) files, which are based on the SI&A Guide.

NEEDS ANALYSIS

DEFICIENCY ANALYSIS

The analysis begins by placing each structure into one of three deficiency categories. These three categories are (1) structurally deficient, (2) functionally deficient, and (3) functionally adequate. Subsequent steps in the analysis differ depending on the deficiency category.

Structurally Deficient

The first step is to determine if a bridge is structurally deficient. The data elements checked to determine whether a bridge will be placed in this category are listed in Table II-1. If the structure meets any one of these criteria it is structurally deficient. Bridges and culverts are treated the same in this step of the analysis.

Functionally Deficient

If a bridge is not found to be structurally deficient, it is then checked to determine whether it is functionally deficient. If any one of the conditions in Table II-2 are met, the structure is functionally deficient.

TABLE II-1

CRITERIA FOR STRUCTURALLY DEFICIENT BRIDGES

Item #	Description	Criteria
#41	Structure closed to traffic	Code "C"
#66	Inventory rating	
	Interstate and Other Fwys & Expys	Less than HS-15
	Other Arterials	Less than HS-11
	Collectors	Less than HS-11
	Local	Less than HS-8
#70	Safe load capacity	"2" or less

Note: See Page A-3 (Appendix A) for factors to convert entries in item #66 to HS load ratings.

TABLE II-2

CRITERIA FOR FUNCTIONALLY DEFICIENT BRIDGES

Item #	Description	Criteria
#32	Approach roadway width *	< 3
#41	Structure posted	Code "P"
#51	Bridge roadway width **	Table B-1
#53	Vertical clearance over deck	Table B-3
#54	Underclearance, vertical	Table B-3
#68	Deck geometry *	< 3
#69	Underclearance	< 3
#70	Safe load capacity	< 4
#71	Waterway adequacy	< 3
#72	Approach roadway alignment +	< 3

* The combination of approach roadway width and deck geometry is a criteria to determine functional deficiency. Neither item alone is a criteria.

** Buried culverts are not checked for bridge roadway width.

+ Approach roadway alignment is a criteria to determine functional deficiency only if the ADT is greater than 500.

Functionally adequate

If a bridge does not fall into one of the above categories, it is functionally adequate, but condition deficiencies may exist. A condition deficiency is identified by comparing the values of specific condition ratings to the minimum tolerable conditions (MTC). If the ratings do not meet the values of the MTC for any element, the bridge is deficient.

DEFICIENCY IDENTIFICATION

For structurally deficient and functionally deficient bridges, the deficiencies are identified as presented above. These categories of bridges are deficient by definition. For functionally adequate bridges, a table of minimum tolerable conditions (MTC) is used. Minimum tolerable conditions are threshold levels used by the model to identify deficiencies. If during the analysis process any data element fails to meet the MTC value for that element, a condition deficiency is identified.

These MTC values are given by rural and urban areas, by functional class, and by replacement or rehabilitation. These last categories relate to the type of improvement that will result (see Improvement Selection, below). That is, if the condition value of any element is less than the replacement MTC value, that element needs replacement. If the value is less than the rehabilitation MTC value, but not less than the replacement MTC value, the element needs rehabilitation.

IMPROVEMENT SELECTION

Table II-3 lists the types of improvements that can be simulated by this process, and Table II-4 shows the combination of deficiencies that result in specified types of improvements. While other combinations are possible for actual bridge improvement, they are considered to be less likely than those chosen for the purposes of this model. The type of improvement considered depends on the deficiency category of the bridge.

Structurally deficient: When a bridge is classified as structurally deficient, the improvement will be replacement of the structure. No other type of improvement will be considered.

TABLE II-3

BRIDGE IMPROVEMENT TYPES

STRUCTURALLY DEFICIENT STRUCTURES

Improvement Type Code	
10	Structure Replacement
12	Culvert Replacement

FUNCTIONALLY DEFICIENT STRUCTURES

10	Structure Replacement		
12	Culvert Replacement		
17	Culvert Widening		
	DECK	SUPERSTRUCTURE	SUBSTRUCTURE
13	Widening		
14	Widening	Rehabilitation	
15	Widening		Rehabilitation
16	Widening	Rehabilitation	Rehabilitation

FUNCTIONALLY ADEQUATE STRUCTURES

	DECK	SUPERSTRUCTURE	SUBSTRUCTURE
Bridge Improvement			
1	Rehabilitation		
2	Rehabilitation	Rehabilitation	
3	Rehabilitation	Rehabilitation	Rehabilitation
4			Rehabilitation
5	Replacement	Rehabilitation	
6	Replacement	Rehabilitation	Rehabilitation
7	Replacement	Replacement	Rehabilitation
8	Replacement		
9	Replacement	Replacement	
10	Structure Replacement		
Culvert Improvement			
11	Culvert Rehabilitation		
12	Culvert Replacement		

TABLE II-4

COMBINATIONS OF DEFICIENCIES AND RESULTING IMPROVEMENT TYPES

STRUCTURALLY DEFICIENT STRUCTURES

Replacement of the entire substructure.

FUNCTIONALLY DEFICIENT STRUCTURES

Widening is selected if it is feasible and if it will correct the identified deficiencies.

If widening is not feasible or if it will not correct the deficiencies, replacement is selected.

FUNCTIONALLY ADEQUATE BRIDGES

Improvement Type Codes	DECK CONDITION				SUPERSTRUCTURE CONDITION				SUBSTRUCTURE CONDITION			
	A	B	C	D	A	B	C	D	A	B	C	D
1	-	X	-	-	X	-	-	-	X	-	-	-
2	-	-	-	X	-	X	-	-	X	-	-	-
3	-	-	-	-	-	X	-	-	-	X	-	-
3	-	X	-	-	-	-	-	-	-	X	-	-
4	X	-	-	-	X	-	-	-	-	X	-	-
5	-	-	X	-	-	X	-	-	X	-	-	-
6	-	-	X	-	-	X	-	-	-	X	-	-
7	-	-	X	-	-	-	X	-	-	X	-	-
8	-	-	X	-	X	-	-	-	X	-	-	-
9	-	-	X	-	-	-	X	-	X	-	-	-
10	-	-	-	X	-	-	-	X	-	-	X	-

FUNCTIONALLY ADEQUATE CULVERTS

11 Culvert condition is less than the rehabilitation MTC.
12 Culvert condition is less than the replacement MTC.

NOTES:
A -- Condition greater than rehabilitation MTC.
B -- Condition less than rehabilitation MTC but greater than replacement MTC.
C -- Condition less than replacement MTC.
D -- MTC does not matter.

Functionally deficient: For a bridge classified as functionally deficient, the improvement will be either widening or replacement. If widening is selected, rehabilitation may also be done to either the superstructure and/or the substructure if needed. Any rehabilitation needed to the deck that is being widened is included in the widening improvement.

Widening will not be done unless the maximum additional width allowed by the model is adequate to correct the width deficiency. If more than the maximum additional width is needed, replacement will be selected. If widening is done, a minimum of 4 feet will be added to the bridge deck width. See "Criteria for Widening a Bridge," below, for more detail on when widening will be selected. The default value for the maximum allowable widening is the width of the existing bridge deck. This means that the maximum

final width of a widened bridge is twice the original bridge deck width. This limitation does not apply to culverts.

Criteria for Widening a Bridge

Warrants: Certain conditions must be met before widening is warranted. If these warrants are met, other conditions are examined to determine whether widening would correct the deficiencies of the structure.

- Unless the bridge roadway width or deck geometry is inadequate, there is no need to widen a bridge. If the bridge roadway width (item #51) is deficient, widening is warranted. Width deficiency is determined by the minimum tolerable condition (MTC) tables in Appendix B.

- If the deck geometry appraisal (item #68) is deficient, widening may be warranted. When this deficiency is identified, the bridge roadway width (item #51) is compared with the approach roadway width (item #32). If the bridge roadway width is less than the approach roadway width, widening is warranted.

Conditions: If widening is warranted and the following conditions are met, widening is the bridge improvement selected. If these conditions are not met, widening either will not correct all of the identified deficiencies or is not feasible. In that case replacement is the improvement selected.

- Can the structure be widened? Of the thirteen structure types (item #43, main span and #44, approach spans) considered by the deterioration model, types 310 (steel thru truss) and 702 (timber) will not be widened. If either the approach or the main spans cannot be widened, the bridge will not be widened. Those classed as 999 (all other), will not be widened unless they are culverts; culverts will be widened when appropriate. (See Table II-7 for a list of the structure types.)

- Will the maximum widening allowed by the model meet design standards for the structure? The default maximum width that will be added to the bridge deck by widening is equal to the existing width. That is, the resulting bridge deck width would be twice the existing deck width. If this width does not provide an adequate bridge roadway width, widening is not sufficient to correct the width deficiency. (The user may substitute a specific maximum width to be added by widening.) This maximum widening amount does not apply to culverts; the extent of culvert widening is unlimited.

- Will widening provide a bridge roadway width equal to or greater than the approach roadway width? If not, replacement would be necessary.

- Do the superstructure and substructure condition ratings (or the culvert and retaining wall rating, in the case of culvert) pass the minimum tolerable conditions test for replacement? If not, the bridge will be replaced. If the condition ratings are less than rehabilitation but greater than replacement MTC values, rehabilitation of the component will be done in conjunction with widening. The "look ahead" feature is used to insure that if the superstructure or the substructure will require rehabilitation within the look ahead period, this work will be done at the time of widening. See the section "Improvement Selection" for more details of the look ahead feature.

- Are there other functional deficiencies that would not be corrected by widening? If so, widening will not be done.

Any deficiencies listed in Table II-2 other than bridge roadway width (item #51) and deck geometry (item #68) will not be corrected by widening.

Functionally adequate: If the bridge is functionally adequate but does not meet the MTC criteria, either replacement or rehabilitation may be selected. Replacement of the entire structure would be done only if the substructure failed the replacement MTC value. Otherwise, some type of rehabilitation will be done. This may include rehabilitation or replacement of the deficient major bridge components. If the substructure needs rehabilitation, and if the bridge is more than 80 years old, the selected improvement is replacement.

An improvement will be selected to correct the condition deficiency. The improvement may be replacement of the entire structure or rehabilitation. Rehabilitation may include any one of a number of combination of rehabilitation or replacement of major components of the structure. For example, it could include deck rehabilitation only, or it could include deck replacement and superstructure rehabilitation. Costs are estimated for each improvement type.

Look Ahead Feature

Before an improvement is selected, the analysis looks ahead a specified number of years (the default is 10 years) to determine whether other deficiencies will occur within this time frame. If other deficiencies are predicted to occur, correction of these deficiencies will be included in the selected improvement. If widening is the selected improvement, the "look ahead" feature is applied to the superstructure and substructure to insure that the widened deck is placed on a sound structure.

IMPROVEMENT SIMULATION

Improvement simulation involves changing the data elements that are changed by the improvement. In the case of replacement or rehabilitation of major bridge components, this involves upgrading the condition rating of the component. Where widening is done, the bridge roadway width and the deck width will be changed. When bridge replacement is done, not only may width and length change, but other dimensions such as vertical clearance may also change.

Table II-5 contains the values that are placed in the structure record when an improvement is simulated. This means that the structure is improved to these given values by the simulated improvement. However, if the existing structure exceeds the width specified in the design standards, widening or replacement will result in a structure at least as wide as the existing bridge.

Replacement

A bridge replacement will improve the bridge to a "new" condition rating. All data elements used in the working file will be upgraded to "new" condition, and to meet the applicable design standards (Appendix A). Replacement generally does not change the structure type, except for timber bridges. The type is changed to code 302, steel stringer/multi-beam or girder. This is the most common type of bridge in the usual length range of timber bridges. This change is made to avoid the relatively rapid deterioration rate for timber bridges after replacement.

TABLE II-5

BRIDGE IMPROVEMENT SIMULATION

This table contains the values for each data element that is changed by an improvement. Only those elements that are coded on the record will be changed.

	IMPROVEMENT TYPE CODE (See Table II-3 for code definitions)																
DATA ELEMENTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
27 Year Built				*1	*1	*1	*1	*1	*2		*2						
41 Bridge Posting										A		A					
43 Str Type, Main										*3							
44 Str Type, Appr										*3							
49 Structure Length										*4							
51 Br Roadway Width										*5		*5	*5	*5	*5	*5	*5
52 Deck Width										*5		*5	*5	*5	*5	*5	*5
53 Vert Over Clear										*6		*6					
54 Vert Under Clear										*6		*6					
58 Deck Cond	7	7	7		9	9	9	9	9	9	7	9	8	8	8	8	8
59 Superstr Cond		7	7		7	7	9		9	9				7		7	
60 Substr Cond			7	7		7	7			9					7	7	
62 Culvert Cond											7	9					7
66 Inventory Rating										*7		*7					
67 Str Condition	/	*8	*8	*8	*8	*8	*8		*8	9	7	9	*8	*8	*8	*8	*8
68 Deck Geometry										9		9	9	9	9	9	9
69 Underclearance										9		9					
70 Safe Load Cap		7	7	7	7	7	7		7	9	7	9		7	7	7	
71 Waterway Adeq										9	7	9					
72 Approach Rdwy										9		9					

NOTES:

*1 For bridge and culvert replacement, the year of construction is change to the year of improvement. The year of major reconstruction is changed to "00."

*2 For improvements with replacement of part of the structure, the year of major reconstruction is changed.

*3 The structure type is changed only when a timber bridge is replaced. It is replaced by type 302.

*4 Structure length may be changed when a bridge is replaced.

*5 When a bridge is widened or replaced, the bridge roadway width is based on the design standards, Appendix A. Deck width is also changed.

*6 When a bridge is replaced, all vertical clearances are based on the design standards, Appendix A.

*7 When a structure is replaced, the inventory rating is upgraded to design standards, Appendix A.

*8 Structural condition is changed to the lesser of superstructure or substructure condition, or left as existing if the existing value is higher.

The length will change for a replacement bridge. The length of the new bridge is the original length times a length adjustment factor. When a culvert is replaced, the length does not change. The deck width of a replacement bridge will be based on the design standards, but will never be less than the width of the existing bridge. (See "widening," below, for specific details.)

The equation to calculate the length of a replacement bridge is:

NEWLEN = OLDLEN + CONST + COEF * OLDLEN

Where: NEWLEN is the length of the replacement bridge
OLDLEN is the original length of the bridge
CONST is a constant (see Table II-6)
COEF is a coefficient (see Table II-6)

TABLE II-6

CONSTANT AND COEFFICIENT FOR BRIDGE LENGTH EQUATION

OLDLEN	CONST	COEF
20-260	21.993	0.0545
261-580	32.303	0.0152
581-940	43.645	-0.00366
941-3400	56.615	-0.01656
> 3400	0	0

Note that the increase in length does not apply to culverts.

Widening

New or widened bridges are constructed to design standards for the specific category of bridge. Widths are designed for 20-year design traffic. The design standards provide the bridge roadway width (item #51). The total deck width (item #52) provides for safety walks and railing. The deck width after replacement or widening is the bridge roadway width plus the difference in items #51 and #52 in the original structure.

Widening will not be done unless specified conditions are met, as presented earlier. If greater bridge roadway width is required than widening can provide, or the other conditions are not met, replacement will be selected.

The maximum width that will be added to the bridge deck by widening has a default value of a width equal to the existing deck width. The minimum width that will be added is 4 feet.

Rehabilitation

A rehabilitation will generally result in a condition rating less than new but better than the MTC value. Certain data elements that are not deteriorated by the model may be brought up to the MTC level by rehabilitation. Any components that are replaced under rehabilitation are rated as new condition.

DETERIORATION RELATIONSHIPS

A traffic growth factor is applied to the ADT when analyzing the bridge records for accruing deficiencies. This factor has been developed by State and functional system by use of the HPMS data. While the change in traffic volumes over time is used in determining bridge roadway width, there is no attempt made to relate the capacity of the roadway carried by the bridge to the capacity of the bridge to accommodate the volume of traffic in a traffic capacity sense. This capability will await a linking of the Bridge Analytical Process with the HPMS Analytical Process which analyzes highway sections contained in the HPMS sample section data.

The deterioration relationships used to deteriorate the bridge conditions over time were developed by the Transportation Systems Center under contract to FHWA. This set of equations uses different coefficients for each State and structure type (item #43). These relationships are applied to the list of structure types contained in Table II-7.

The basic equation is:

CONCAL = CONREC - (A * AGE + B * ADT * AGE) * [1 / (1 + ELF)]

Where:

CONCAL is the calculated deck condition value.
CONREC is the deck condition value at the beginning of the analysis.
A is a coefficient given by State and structure type.
B is a constant for the given equation.
AGE is the number of years since the condition was previously determined.
ADT is the average daily traffic on the structure.
ELF is the extended deck life factor in decimal form.

The extended deck life factor applies to bridge decks that were constructed after 1975. This factor was added by FHWA, assuming that cathodic or other type of protection will extend the life of the deck by 50% compared to decks constructed in 1975 or earlier. This value may be varied by the user.

TABLE II-7

BRIDGE TYPES RECOGNIZED

Code	Structure Type
101	Concrete slab
102	Concrete stringer/multi-beam or girder
104	Concrete tee beam
201	Concrete continuous slab
204	Concrete continuous tee beam
205	Concrete continuous box beam or girders -- multiple
302	Steel stringer/multi-beam or girder
310	Steel thru truss
402	Steel continuous stringer multi-beam or girder
502	Prestressed concrete stringer/multi-beam or girder
505	Prestressed concrete box beam or girders -- multiple
702	Timber stringer/multi-beam or girder
999	All others
x19	Culverts ("x" is any valid code)

Note that the code "999" is not taken from the SI&A Guide, but is assigned by the process to replace any code other than the specific codes listed above.

The research on bridge deterioration was confined to bridges not older than about 25 years because of data limitations. Therefore it did not adequately address the accelerated deterioration generally thought to occur in older bridges. To address this concern, the deterioration coefficients of age (listed as "A" in the list above) used in the deterioration equations are increased by 50% for bridges over 25 years old.

The deterioration relationships developed by TSC were only for the major bridge components of deck, superstructure, and substructure. Other elements that are deteriorated in this model are culvert and retaining wall conditions (item #62), structural condition appraisal (item #67), and safe load capacity (item #70).

The deterioration of structural conditions and safe load capacity is based on the deteriorated condition of the superstructure and substructure. The values of the elements to be deteriorated are

decreased so that they do not exceed the value of the condition rating of whichever of these major bridge components has the lower value.

The deterioration of culvert and retaining wall condition is based on an assumed life of 80 years. The deterioration equation is given below. This equation assumes a linear deterioration for 80 years to decrease the condition value from 9 to 1, the assumed failure point.

CP = CL - 0.1 * AGE

Where: CP = Deteriorated condition
CL = Condition at last deterioration cycle
AGE = number of years since last condition value

TABLE II-8

LOAD CAPACITY DETERIORATION

Lower condition rating, Superstructure or Substructure	Ratio of current capacity to design capacity
6 or higher	1.00
5	0.95
4	0.85
3	0.75
2	0.50
1	0.20
0	0

COST ESTIMATION

The costs vary by State and Federal-Aid System. Costs are based on replacement cost, and the various rehabilitation costs are based on a percentage of replacement cost. All costs are estimated on the basis of square feet of deck. Deck area is calculated by multiplying the structure length (item 49) times the deck width (item #52).

The costs for buried culverts are by linear foot along the roadway centerline, by length category.

Replacement: When the type of improvement is replacement, the replacement cost is used, multiplied by the deck area of the new bridge.

Widening: When widening is done, the costs are multiplied by a widening cost factor. Widening costs include the costs for any required rehabilitation of the existing deck. If rehabilitation of the superstructure or substructure are required, additional costs are shown. These costs are based on the area of the original deck.

Rehabilitation: When rehabilitation is done, the costs are multiplied by rehabilitation cost factors, using the existing deck area.

ANALYSIS RESULTS

The printed output of this analysis lists the options in effect. These include the inventory year, the base year for the analysis, the cycle length, and the factor for extending bridge life of decks constructed after 1976.

The output also contains the criteria for deficient structures. These are the criteria for determining the deficiency category of each structure. This includes the minimum tolerable conditions for structures classified as functionally adequate. The number of structures that failed the specified criteria are shown. Design standards are contained in another table.

The number of deficient bridges and the costs of selected improvements are shown. These are listed by the general improvement types of (1) rehabilitation, (2) widening, and (3) replacement. The numbers of structures and the costs are also arranged by backlog and future needs.

The averaged condition values for the bridge population, and the funds expended in the analysis are displayed.

INVESTMENT ANALYSIS

The investment analysis is an option that can be added to the needs analysis. It cannot be run without the needs analysis, upon which it builds. The investment analysis provides for the input of a specific investment amount for each of up to four funding periods. These funding periods can analyze a total of up to 20 years.

PRIORITY RANKING

When funds are limited, as they usually are in the real world, it is necessary to decide which deficient structures are most in need of improvement. This is done by a priority ranking procedure. The elements used in this ranking, and the procedures to determine the ranking points, are shown below. A greater number of points indicates a higher priority for improvement.

Sufficiency rating

The point ranking value for sufficiency rating is calculated by the equation:

V = 100 - Sufficiency rating

The sufficiency rating is calculated by the procedure described in the SI&A Guide. A rating of 100 points indicates a structure that does not need improvement. A rating of 0 is the worse possible sufficiency rating. The rating is used by FHWA to determine eligibility for Federal-aid bridge funds. However, in the Bridge Analytical Process, the sufficiency rating is used only as a part of the prioritization scheme. Its value is subtracted from 100 to comply with the ranking scheme.

Deficiency category

The point ranking value for deficiency category is as follows:

Structurally deficient:	150 points
Functionally deficient:	75 points
Functionally adequate:	0 points

Functional class (Item #26)

The point ranking value assigned to the ranking scheme depending on functional class, is as follows:

Rural

Interstate	100
Other principal arterial	80
Minor arterial	60
Major collector	40
Minor collector	20
Local	0

Urban

Interstate	100
Other freeways and expressways	90
Other principal arterials	80
Minor arterials	60
Collectors	30
Local	0

AADT (Item #29)

The AADT for the improvement year is used for this purpose. The point ranking value for AADT is calculated by the equation:

$V = ADT^{0.36}$

The equation provides for a non-linear relationship to AADT to allow a reasonable number of improvements to be simulated for facilities with low ADT. It also provided a numeric value consistent with those for other ranking criteria.

Combination of Detour Length (Item #19) and Structure Open, Posted, or Closed to Traffic (item #41)

The point ranking value is based on the posting of the bridge and the detour length. The weight of detour length depends on the posting. A bridge that is closed forces all traffic to detour, while a load posted bridge forces heavier vehicles to detour.

Closed	100 + 4 * DL
Posted	50 + 2 * DL
Adequate	0

Where DL is the detour length in miles.

ANALYSIS RESULTS

The printed output of this analysis lists the analysis options in effect. The output also contains the criteria for deficient structures. These are the criteria for determining the deficiency category of each structure. This includes the minimum tolerable conditions for structures classified as functionally adequate. The number of structures that failed the specified criteria are shown. Design standards are contained in another table.

Another table contains the number of deficient bridges and the costs of the selected improvements. These are listed by the general improvement types of (1) rehabilitation, (2) widening, and (3) replacement. The numbers of structures and the costs are also tabulated by backlog needs, needs for each of up to 4 specified time periods, and a total of all deficient bridges and costs of improvements. The number of deficient bridges funded and not funded are shown.

The averaged condition values for the bridge population, and the funds expended in the analysis are also displayed.

PART II

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM

1989

Objective of Report

Section 144(i) of Title 23, U.S. Code, requires a biennial report to Congress on the Highway Bridge Replacement and Rehabilitation Program (HBRRP) and the status of the National Bridge Inventory (NBI). It also requires recommendations for program improvement. This chapter, the ninth report on the HBRRP, will describe in detail the progress made in administering the HBRRP through June 30, 1988, as well as the status of bridge inventories for both Federal-aid and off-system highways. It also summarizes the status of bridge management systems.

Special Bridge Replacement Program

Congress began the Special Bridge Replacement Program (SBRP) in 1970, eventually authorizing $816.5 million through fiscal year (FY) 1978. In all, the Federal Highway Administration (FHWA) has approved 1,584 bridges for design or construction under the SBRP.

By law, SBRP funds remain available until they are used to reimburse a State for eligible project costs. Although all SBRP funds have been obligated for several years, small amounts still become available for re-obligation as States complete ongoing projects and determine final costs. As of June 30, 1988, the States had an unobligated balance of SBRP funds totalling $400,000. The SBRP will expire when the States have used all the funds.

Highway Bridge Replacement and Rehabilitation Program

The Surface Transportation Assistance Act (STAA) of 1978 replaced the SBRP with the HBRRP. By enacting this legislation, Congress acknowledged that our Nation's bridge needs had reached a critical level. The act authorized a total of $4.2 billion for FY's 1979 through 1982 to improve bridges on public highways throughout the Nation.

The 1982 STAA continued the HBRRP at record funding levels by authorizing a total of $7.05 billion for FY's 1983 through 1986. This total was revised downward by $150 million in FY 1986 to $6.9 billion as a result of the Gramm-Rudman-Hollings Act. The Surface Transportation and Uniform Relocation Assistance Act (STURAA) of 1987, Public Law (PL) 100-17, extended the HBRRP by authorizing $8.15 billion for FY's 1987 through 1991, or $1.63 billion a year.

Funding for the HBRRP is divided into two categories: (1) apportioned funds that are distributed according to relative State needs, and (2) discretionary funds that are set aside for allocation by the Secretary of Transportation to replace or rehabilitate deficient, critically needed, high-cost bridges on the Federal-aid system. The maximum Federal share is 80 percent of eligible project costs. Appendix A of this part contains current regulations for the HBRRP funding program.

Apportioned Bridge Funds

As required by Section 121 of the 1982 STAA, the FHWA must revise each State's apportionment factor annually to reflect changing needs and actual construction costs. To establish the apportionment factor, the FHWA applies construction costs to the four categories of eligible deficient bridge projects in each State. These categories are: (1) replacement of Federal-aid system bridges, (2) replacement of off-system bridges, (3) rehabilitation of Federal-aid system bridges, and (4) rehabilitation of off-system bridges. The apportionment factor is the ratio of each State's needs compared with the national need. By law, each State must receive at least 0.25 percent, but not more than 10 percent, of the total funds available.

Discretionary Bridge Funds

Discretionary bridge funds finance Federal-aid system bridge replacement or rehabilitation projects with an estimated cost exceeding $10 million. In smaller program States, bridge projects costing less than $10 million are eligible if they cost more than twice the amount apportioned to the State for the year funds are requested. The FHWA uses proposed funding schedules submitted by the States for candidate bridges to establish master funding plans. The plans are revised annually or more often, if necessary, based on the latest data from the States.

The 1982 STAA directed the Secretary of Transportation to develop a regulation on the selection of discretionary bridge projects. The regulation, which went into effect December 19, 1983 (see Appendix B), established a formula for calculating a rating factor from criteria included in the legislation. The selection process gives funding priority to discretionary bridge projects already begun under the program. In addition, candidate bridges not previously selected but having a computed rating factor of 100 or less are eligible for consideration.

As of June 30, 1988, the discretionary planning list included 217 bridges submitted by the States as candidates for replacement or rehabilitation. The estimated cost of these 217 projects is $6.69 billion, including $1.93 billion in discretionary bridge funds already allocated. If they were all funded under the discretionary bridge category, the 80 percent Federal share of eligible costs would be $5.35 billion. The planning list includes all State candidates, even though some unfunded projects are not eligible under the 1983 regulation.

The Department of Transportation (DOT) had selected 107 of the 217 bridge projects for discretionary bridge funding as of June 30, 1988 (see Table 3). The total cost of these 107 projects is $3.25 billion, of which $1.93 billion had been allocated as of that date (see Table 1D). This figure does not equal 80 percent of estimated costs because discretionary bridge projects are not all funded at 80 percent of total costs. Some of these projects were begun with funds from other categories. In other cases, the State presented an acceptable proposal to combine discretionary bridge funds with apportioned bridge and State funds. The FHWA estimates that approximately $600 million more in Federal funds will be required to complete these ongoing projects.

The total estimated cost of the remaining 110 projects is $3.44 billion. They would require approximately $2.75 billion in Federal funds to match the full 80-percent share under the discretionary bridge category.

State requests vary yearly as candidate projects advance in priority or are delayed. Additional projects will be submitted as existing bridges age and deteriorate to the point that rehabilitation or replacement is needed. Other candidates may be withdrawn because funding becomes available from other sources.

New Provisions of the STURAA of 1987

The 1987 STURAA changed the HBRRP in several ways:

(1) The act extended HBRRP eligibility to low-water crossings, bridges destroyed before 1965, replacement of ferries in existence on January 1, 1984, and road bridges rendered obsolete by U.S. Corps of Engineers flood control or channelization projects.

(2) When a bridge replacement or rehabilitation project is constructed entirely with State or local funds, the State may request any amount in excess of 20 percent of the construction cost to be credited as the non-Federal share of the cost of a federally funded project. To merit the credit, the State or locally funded project must meet HBRRP standards and regulations. Further, upon completion, the project must result in a bridge that is no longer deficient.

(3) Each State is required to complete an inventory of all bridges on or off the Federal-aid system to determine their historic significance.

Program Status

Each year, the FHWA asks the States to update the NBI as part of the continuing inventory and inspection program required for all public highway bridges. Many States update their data more often. The total number of highway bridges, the number on the different systems, and the number of deficient bridges will continue to fluctuate with each report because of the ongoing inspection program, highway system changes, construction of new bridges, HBRRP projects, and demolition or closing of other bridges (see Tables 4A, 4B, 5A, and 5B). The table on the following page shows the Status of the Nation's Bridges, based on the NBI, and changes since the Eighth Annual Report.

Although the funding totals in this report cover only projects developed under the SBRP or the HBRRP, many projects were developed with other funds. Since enactment of the 1982 STAA, the FHWA has authorized between 6,000 and 7,000 bridge projects for development each year with all categories of Federal-aid funds. In calendar year 1987, the 6,800 authorized Federal-aid highway bridge projects cost an estimated $4.2 billion. In addition, most State and local governments carry out their own bridge projects without Federal assistance. Based on the limited data available, the FHWA estimates the annual cost of these non-federally assisted highway bridge improvement projects to be between $500 million and $1 billion. These State and locally funded bridge projects improve or replace approximately 1,500 to 2,500 bridges annually.

STATUS OF THE NATION'S BRIDGES

	Eighth Annual HBRRP Report As of December 31, 1986			From NBI June 30, 1988		
	Federal-aid	Off-system	Total	Federal-aid	Off-system	Total
Number of bridges inventoried and classified	271,300	304,307	575,607	274,583	303,127	577,710
Number of structurally deficient bridges [a] (includes closed bridges)[b]	36,321	95,241	131,562	37,300	98,526	135,826
Number of functionally obsolete bridges [a, b]	40,542	71,542	112,084	39,892	62,639	102,531
Number of bridges that are load posted[c]	19,546	92,359	111,905	20,607	111,331	131,938
Additional bridges that should be load posted[c]	5,849	30,537	36,386	2,267	17,125	19,392
Total bridges that are or should be load posted[c]	25,395	122,896	148,291	22,874	128,456	151,330
Number of bridges closed to all traffic (these bridges may be closed temporarily for repairs or closed permanently)	595	3,530	4,125	606	4,580	5,186
Total number of bridges funded under the bridge program[d] SBRP	1,581		1,581	1,584		1,584
HBRRP	13,763	10,790	24,533	15,981	12,733	28,714
Total	15,344	10,790	26,134	17,565	12,733	30,298
Number of replaced or rehabilitated bridges open to traffic (SBRP & HBRRP)[d]	8,430	6,123	14,533	10,718	8,064	18,782
Bridges under construction and/or design (SBRP & HBRRP)[d]	6,914	4,667	11,581	6,847	4,669	11,516

[a] A structurally deficient bridge, as defined by FHWA, is one that (1) has been restricted to light vehicles only, (2) is closed, or (3) requires immediate rehabilitation to remain open; a functionally obsolete bridge is one on which the deck geometry, load carrying capacity (comparison of the original design load to the current State legal load), clearance, or approach roadway alignment no longer meets the usual criteria for the system of which it is an integral part.

[b] The number of deficient bridges (structurally deficient and functionally obsolete) reflects the FHWA's interpretation of the States' inventory data for this program, and may not agree with an individual State's records for these two categories. See pages 30 and 31 for breakdown.

[c] Bridges that require load posting fall into two groups. One group includes structurally deficient bridges that have deteriorated to the extent that they cannot carry the load for which they were designed. The second group includes functionally obsolete bridges that are in good condition but the current State legal load exceeds the original design load and therefore, the bridges require posting. The number of bridges that are closed or posted or that should be posted but are not, is taken from the NBI as submitted by the States.

[d] These counts include only bridges funded with HBRRP and SBRP funds. Many bridge improvements are also made using other categories of Federal-aid highway funds and State or local funds.

Changes in the Number of Deficient Bridges

Since December 31, 1986, which was the cut-off date for the Eighth Annual Report, the total number of deficient bridges has decreased by 5,289 (2.2 percent). This net decrease reflects the many bridges that have been replaced or rehabilitated while others have deteriorated to the point that they are now considered deficient. Overall, the number of functionally obsolete bridges decreased, offsetting an increase in the number of structurally deficient bridges. Some functionally obsolete bridges moved to the structurally deficient category as they aged and were subjected to more traffic.

The overall decrease continues a trend that was first reported on in the Sixth Annual Report to Congress on the bridge program (December 1984 data). Since then, the number of deficient bridges has decreased by 21,949 (9.2 percent). During this same time, the number of deficient bridges on the Federal-aid systems increased with each report, for a total increase of 2,943 (4 percent). However, the number of deficient off-system bridges decreased by 24,892 (13.4 percent). The following table shows changes in the number of deficient bridges since December 1982 as reported in bridge program reports.

CHANGES IN THE NUMBER OF DEFICIENT BRIDGES

Date	Federal-Aid			Off-system			
	Structurally Deficient	Functionally Obsolete	FA Total	Structurally Deficient	Functionally Obsolete	OS Total	Total
Dec 82	28,070	41,575	69,645	104,084	79,467	183,551	253,196
Dec 83	30,996	43,253	74,249	105,351	80,706	186,057	260,306
Dec 84	33,389	41,809	75,198	107,419	77,558	184,977	260,175
Dec 85	35,433	40,499	75,932	100,303	67,682	167,985	243,917
Dec 86	36,321	40,542	76,863	95,241	71,542	166,783	243,646
Jun 88	37,300	39,892	77,192	98,526	62,639	161,165	238,357

The fact that a bridge is "deficient," either structurally or functionally, does not imply that it is likely to collapse or that it is unsafe. With proper load posting and enforcement, most structurally deficient bridges can continue to serve traffic when restricted to the posted maximum loads. Some functionally obsolete bridges have geometric deficiencies (for example, they may be narrower than modern standards require) that can be mitigated, but not eliminated, by the use of roadway striping, signs, signals, and crash cushions.

Load-Posted Bridges

About 151,000 bridges (26 percent) nationwide are or should be load posted. A large number of these, over 128,000, are off the Federal-aid system. Thus, 42 percent of the off-system bridges either are or should be load posted. Just over 8 percent (about 23,000 bridges) of Federal-aid system bridges are or should be load posted.

The number of bridges that should be load-posted but are not is still large. However, significant changes have occurred. Through the continuing efforts of the States and the FHWA, the number of bridges which should be load posted but are not has dropped from the 36,400 bridges reported in the Eighth Annual Report to about 19,400. The actions taken by the FHWA in order to reduce the number include the temporary withholding of Federal-aid approvals for projects requested by government jurisdictions not complying with the requirements of the National Bridge Inspection Standards (NBIS). Many of the bridges identified as not posted are currently being posted. In fact, the FHWA has been informed that an additional 1000 bridges have been load posted in July and August of 1988.

Sufficiency Rating

The FHWA, in consultation with the States, establishes general bridge priorities by assigning a sufficiency rating to each bridge inventoried. The lower the sufficiency rating, the higher the priority for replacement or rehabilitation.

The sufficiency rating is based on the following general categories and relative percentages:

55 percent	- structural adequacy and safety
30 percent	- serviceability and functional obsolescence
15 percent	- essentiality for public use
100 percent	

From the States' inventory data, the FHWA compiles the HBRRP selection list for each State. The list includes all deficient bridges with a sufficiency rating of 80 or less. All these bridges are eligible for rehabilitation. Bridges with a sufficiency rating less than 50 are also eligible for replacement. The FHWA requires that the States consider all feasible alternatives, including rehabilitation, before approving replacement. Rehabilitation, where feasible, is usually less expensive than replacement.

While the sufficiency rating has served well as a tool for ranking bridge priorities on a national basis, it has some significant shortcomings, including a relative lack of sensitivity to the functional class of highways that particular bridges carry. In order to overcome this shortcoming, the FHWA is studying other priority ranking and potential HBRRP eligibility criteria which would be based upon required levels of service on various classes of highways.

Status of Funds

Congress has authorized the following funds for the HBRRP:

HBRRP FUNDS AUTHORIZED

	1978 STAA FY's 1979-82 (Million)	1982 STAA FY's 1983-86 Million	1987 STURAA FY 1987 (Million)	FY 1988 (Million)
Secretary's discretionary funds	$ 800	$ 800	$ 225[d]	$ 225[d]
Apportioned funds excluding HPR[a] funds (See Tables 1A - 1C)	3,116	5,920	1,352	1,352
Acceleration of bridge projects	200	0	0	0
Administration	84	85	28	28
HPR funds[b]	0	90	21	21
Special Funding (Eugene Talmadge Memorial Bridge)	0	5	0	0
SHRP Funds[e]	0	0	4	4
Totals	$4,200	$6,900[c]	$1,630	$1,630

a HPR - Highway Planning and Research. The 1982 STAA required that 1-1/2 percent of apportioned HBRRP funds, as well as the apportioned Federal-aid systems funds, be deducted for HPR.

b These funds are the amounts derived from bridge funds; however, they may be used for planning and research related to highways as well as bridges.

c The Consolidated Omnibus Budget Reconciliation Act of 1985 (Public Law 99-272) changed the FY 1986 authorization for the HBRRP from $2.05 billion to $1.9 billion.

d The 1987 STURAA required that a portion of the cost of demonstration projects be taken from discretionary funds, including bridge. This reduced the $225 million authorized to $185 million in FY 1987 and $214 million in FY 1988.

e SHRP - Strategic Highway Research Program. The 1987 STURAA required that $^1/_4$ percent of apportioned HBRRP funds, and other apportioned Federal-aid funds, be deducted for SHRP.

From FY 1979 through FY 1987, the States obligated a total of $11.26 billion of HBRRP funds. This amount was approximately 90.9 percent of the total discretionary and apportioned funds available (compared with the 90.4 percent shown in the Eighth Annual Report). The States obligated an additional $1.05 billion during the first three quarters of FY 1988. The following tabulation shows discretionary and apportioned fund obligations:

HBRRP OBLIGATIONS BY FISCAL YEAR

Fiscal Year	Secretary's Discretionary Fund (Million)	Apportioned Funds (Million)	Total Funds Obligated (Million)
1979	$ 178.9	$ 423.4	602.3
1980	140.6	619.4	760.0
1981	164.4	730.8	895.2
1982	233.4	744.9	978.3
1983	216.2	1,196.0	1,412.2
1984	238.1	1,512.2	1,750.3
1985	206.3	1,382.1	1,588.4
1986	215.2	1,442.5	1,657.7
1987	188.9	1,427.4	1,616.3
1988 (3qtrs)	149.4	899.4	1,048.8
Total	$1,931.4	$10,378.1	$12,309.5

The $12.3 billion is an increase of $2.4 billion over the amount obligated through December 31, 1986, and shown in the Eighth Annual Report. The $2.4 billion was used to improve 4,164 bridges.

In addition to the $12.3 billion of HBRRP funds obligated through June 30, 1988, the States spent $7.5 billion of other Federal-aid funds for bridge replacement or rehabilitation projects during the same period. This amount includes funds used only for bridge work and does not include related items such as approaches, utility relocation, right-of-way costs, or funds for new bridges on new roadway alignments.

The $7.5 billion in non-HBRRP Federal-aid obligations for bridge replacement or rehabilitation was distributed among the Federal-aid systems as follows:

OTHER FEDERAL-AID FUNDS OBLIGATED FOR BRIDGE REPLACEMENT AND REHABILITATION
(in millions)

Fiscal Year

System	1979	1980	1981	1982	1983	1984	1985	1986	1987	1st three quarters 1988	Total
Interstate	$185	$149	$212	$358	$285	$534	$738	$822	$845	$704	$4,832
Primary	65	205	115	122	144	102	178	230	267	201	1,629
Secondary	18	16	16	37	40	32	57	38	43	26	323
Urban	50	36	28	52	101	86	100	82	82	57	674
Total	$318	$406	$371	$569	$570	$754	$1,073	$1,172	$1,237	$988	$7,458

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This table has been updated to reflect changes due to the obligation of funds when advance construction projects are converted and the final cost of completed construction projects. This table was last updated in 1984.

Section 144(g)(2) of Title 23, U.S. Code, requires the States to use at least 65 percent of each year's HBRRP apportionment on Federal-aid system bridges (see Tables 1A and 2A). In addition, the States must use no less than 15 percent on bridges off the Federal-aid systems (see Tables 1B and 2B). The remaining 20 percent of each State's apportionment of HBRRP funds may be used on or off the Federal-aid systems at the discretion of the State (see Tables 1C and 2C).

As noted earlier, the 1987 STURAA established HBRRP fund eligibility for low-water crossings, bridges destroyed before 1965, replacement of ferries in existence on January 1, 1984, and road bridges rendered obsolete by U.S. Corps of Engineers flood control or channelization projects. Through June 30, 1988, two States had obligated $1.25 million for the new categories of eligible projects.

Most States also use apportioned HBRRP funds to inventory, inspect, and evaluate bridges under the requirements of the NBIS. Since the beginning of the HBRRP in 1979, the States have obligated $387.0 million for this purpose. In all, 43 States obligated $239.9 million for inspection of Federal-aid system bridges. A somewhat different 41 States obligated $147.1 million to inspect off-system bridges. In addition, 14 States obligated $1.4 million to inventory bridges for historic significance as first authorized in the 1982 STAA. Some States use non-HBRRP funds for the NBIS and historic inventories. Nine States obligated $9.45 million in HBRRP funds to purchase and install the initial set of load posting signs at load deficient bridges.

The information reported in this section does not include State and local funds spent on bridges.

Rehabilitation

The 1978 STAA expansion of the bridge program to permit rehabilitation gave State and local governments greater flexibility in deciding how to correct deficiencies. Bridge rehabilitation projects continue to be an important part of the bridge program. Through FY 1986, the States had used 18.3 percent of obligated

HBRRP funds on rehabilitation projects. The percentage has risen to 19.2 percent through June 30, 1988.

In developing HBRRP projects, the States consider rehabilitation as an alternative to replacement. Rehabilitation, where feasible, often costs far less than replacement and is a cost-effective procedure for larger bridges. Rehabilitation can extend bridge service life if undertaken before deterioration reaches an advanced stage. By accomplishing rehabilitation early, a State can avoid more costly replacement, and the bridge can provide reliable service for many years.

Off-System Funds

As noted previously, the States must use at least 15 percent of the apportioned HBRRP funds on off-system bridges. The States may use another 20 percent either on or off the Federal-aid systems.

From FY 1979 through June 30, 1988, the States obligated a total of $2.12 billion (20.5 percent of the total apportioned funds) for off-system bridges, including $460 million since December 31, 1986 (22.8 percent of the amount obligated during this period). This total includes $640 million (32 percent) from the 20 percent of apportionments that can be used on or off the Federal-aid systems. The States obligated a total of $2 billion of these funds with the remaining $1.36 billion (68 percent) for Federal-aid system bridges.

Bridge program legislation provides for reduced expenditure on off-system bridges if a State does not have enough deficient off-system bridges to justify using 15 percent of its apportionment on them. None of the States or Puerto Rico has requested a waiver. The District of Columbia has very few deficient off-system bridges under its jurisdiction, and, therefore, annually requests and receives a waiver of the 15-percent requirement. The funds are transferred to the 20 percent of the apportionment which may be used on or off the Federal-aid system.

NBIS Revisions

Federal law requires the FHWA to issue national inspection standards for bridges. On August 26, 1988, the FHWA published revisions to the NBIS in the Federal Register. The revisions became effective on October 25, 1988. Appendix C contains the NBIS, as amended.

The specific changes in the NBIS deal with (1) frequency of inspection, (2) inspection of fracture critical members, (3) underwater inspection and other special inspections, (4)

certification of bridge inspectors, and (5) prompt updating of bridge inventory files after a change in the status of bridges. The revised regulation will have a positive effect on the overall safety of the Nation's highway bridges.

Bridge Management Program

Since the earliest days of highway development, officials have selected bridges for construction, replacement, or rehabilitation on the basis of engineering judgment, intuition, political pressure, citizen outcry, and other subjective criteria. This method not only distorts priority selection of projects, but creates disorder in program planning and renders data collection less useful than might otherwise be the case. Establishing sufficiency ratings under the Federal bridge program was a major step in bringing some sense of order to bridge management.

The FHWA and many State and local governments have seen bridge management systems as the next important step and a must for overall bridge program management to face growing bridge needs. Currently 40 percent of all bridge deck area on the Federal-aid systems is between 15 to 35 years old, reflecting the bridge building boom of the 1950's and 1960's. Most decks of this era were built with minimum cover for reinforcing steel and without corrosion protective systems. Many of these decks may already need maintenance and rehabilitation and some may have to be replaced soon. The next few decades will see a large increase in the need for bridge maintenance, rehabilitation, and replacement.

A comprehensive bridge management system is an integrated set of formal procedures for directing or controlling all activities related to bridges. Unlike sufficiency ratings, bridge management systems give officials a systemwide perspective that allows them to examine all bridges collectively rather than on a bridge-by-bridge basis. In addition, they offer the capability of assessing the trade-offs and implications of present actions and policies on long term needs.

A comprehensive bridge management system should provide reliable short-term and long-term predictive capabilities. It should get the most out of both the corrective strategies used and

the timing and dollar expenditures for maintenance, repair, rehabilitation, or replacement of bridges all the while maintaining public safety and convenience or primary goals.

In accordance with Section 162 of the 1987 STURAA, the FHWA conducted a special bridge management study to, in part, see how much progress the States are making in developing comprehensive bridge management systems. The study was sent to Congress on April 11, 1988.

As reported in the study, bridge management systems are in an early development and implementation phase. Although some foundation has been laid by earlier studies, adequate tools for basing allocation of near-term budgets on an analysis of long-term network needs have yet to be developed. The analytical tools necessary for bridge management are complex, and their development is clearly an interdisciplinary task. While highway agencies can supply bridge engineering talents, they may lack depth in other needed disciplines such as statistics, operations research, economics, and management science. When outside assistance is needed, the States will be less likely to develop bridge management systems rapidly.

Because of the complexity and cost of bridge management systems, it does not make sense for each State to develop its own system independently. Even though each State's system will have unique features, all systems will have many features in common. Most of the analytical routines, if properly designed, can serve the needs of every State.

Several efforts are underway to promote bridge management systems. The FHWA has completed a series of 2-day demonstration project workshops on bridge management systems in 46 States. These workshops, aimed at acquainting all States with bridge management system concepts, explored the relevant engineering and economic issues and presented an overview of methodologies and concepts in bridge management. The workshops were intended to stimulate State interest in bridge management systems and prompt a number of studies to be planned or developed.

In addition, the FHWA has initiated work to sponsor a nationally coordinated study for development of a network optimization model that will be suitable for general use by the States. A group of States will be involved to provide a bank of bridge experts for model development input. The latter study will require a minimum of 2 years to complete.

The Transportation Research Board, through its National Cooperative Highway Research Program, has funded an ongoing study to develop an umbrella bridge management system the States can tailor to their own needs. The target completion date for this study is November 1989.

Summary

The HBRRP continues to build momentum as the States enthusiastically participate in an unprecedented rebuilding of the Nation's deficient bridges. Even with obligation authority limited by Federal law, the States had an overall obligation rate through FY 1987 of 90.9 percent of the total HBRRP funds available. This high level of program activity is expected to continue in the years ahead.

A net decline in the total number of deficient bridges (21,949), which began in 1984, continued through the reporting period of June 30, 1988. From December 31, 1986, to June 30, 1988, the number decreased by 5,289 bridges.

Since 1984 the number of deficient Federal-aid system bridges has continued to rise (4.0 percent). At the same time, the number of deficient off-system bridges decreased by 13.4 percent. This trend is expected to continue as the large number of Federal-aid system bridges built in the late 1950's and the 1960's continues to grow older.

The number of bridges which should be posted but are not has decreased significantly since the Eighth Annual Report. The FHWA and the States are continuing to work to reduce this number.

The FHWA is encouraging the States to develop their own bridge management systems. However, most of these systems are in an early stage of development.

Continued cooperative efforts by the FHWA and the States are essential to produce systems with common features that can be adapted to fit the unique requirements of individual States.

TABLE 1A

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

STATUS OF FUNDS PROVIDED FOR
BRIDGE REPLACEMENT & REHABILITATION MANDATORY AND OFF-SYSTEM - 130

AS OF JUNE 30, 1988

STATE	TOTAL AVAILABLE	OBLIGATIONS DURING FY 88	OBLIGATIONS TOTAL TO DATE	UNOBLIGATED BALANCE
ALABAMA	145,342,964.00	9,669,137.34	135,776,284.22	9,566,677.78
ALASKA	19,130,564.00	871,771.00	15,814,281.56	3,316,282.44
ARIZONA	19,130,564.00	321,703.99CR	12,694,794.12	6,435,769.88
ARKANSAS	130,813,686.00	7,899,110.00	125,611,471.00	5,202,215.00
CALIFORNIA	257,868,517.00	21,318,416.03	267,733,539.87	4,134,977.13
COLORADO	31,833,994.00	2,743,650.99	84,680,694.85	6,953,299.15
CONNECTICUT	149,138,178.00	23,698,456.98	138,182,388.70	10,955,789.30
DELAWARE	19,130,564.00	648,562.14	15,314,815.84	3,815,748.16
FLORIDA	304,710,142.00	22,373,195.00	163,970,046.00	340,096.00
GEORGIA	183,961,994.00	12,708,482.74	167,432,338.46	16,549,655.54
HAWAII	21,522,399.00	1,370,915.98	20,661,136.98	861,262.10
IDAHO	29,885,061.00	2,271,119.36	29,551,624.68	33,436.32
ILLINOIS	348,837,228.00	26,759,240.37	348,778,934.33	58,293.67
INDIANA	144,549,654.00	8,436,369.14	125,123,675.51	19,425,978.49
IOWA	186,346,857.00	13,521,690.29	169,239,361.82	17,107,495.18
KANSAS	205,062,900.00	9,014,875.90	166,941,861.63	38,440,638.37
KENTUCKY	287,181,994.00	18,992,198.81	177,840,992.99	9,341,361.01
LOUISIANA	261,681,824.00	15,966,399.77	232,969,746.17	28,711,787.83
MAINE	34,045,906.00	3,217,031.20	32,828,849.54	1,217,056.46
MARYLAND	133,822,940.00	143,224.00CR	115,352,806.00	18,470,134.00
MASSACHUSETTS	189,893,621.00	2,259,667.34	164,794,513.34	25,099,107.66
MICHIGAN	111,079,598.00	14,634,142.38	106,643,209.62	4,436,388.38
MINNESOTA	150,281,151.00	1,906,861.35CR	140,994,323.24	9,286,827.76
MISSISSIPPI	137,388,113.00	8,410,193.00	129,657,754.00	7,730,359.00
MISSOURI	288,029,234.00	19,940,739.56	260,259,913.62	27,769,320.38
MONTANA	49,862,235.53	1,454,573.46	38,411,368.48	11,390,867.07
NEBRASKA	127,428,426.00	4,550,359.21	110,734,881.49	16,694,544.51
NEVADA	19,130,564.00	669,246.00	15,347,971.00	3,782,993.00
NEW HAMPSHIRE	56,710,649.00	1,896,869.71	48,594,378.26	7,816,270.74
NEW JERSEY	310,327,485.00	24,631,846.42	276,142,626.02	34,184,858.98
NEW MEXICO	28,347,023.00	469,503.07	25,329,311.04	3,016,711.96
NEW YORK	724,712,117.00	67,718,469.48	719,532,321.00	5,179,796.00
NORTH CAROLINA	225,564,901.00	23,520,661.00	195,909,476.00	29,655,431.00
NORTH DAKOTA	41,179,165.00	4,867,662.85	40,753,923.52	331,241.48
OHIO	230,529,595.00	29,236,335.50	215,417,963.00	15,111,632.00
OKLAHOMA	149,716,190.00	21,421,102.30	121,394,564.21	28,321,625.79
OREGON	72,833,481.00	2,116,942.37	67,898,058.92	4,935,422.08
PENNSYLVANIA	482,564,358.00	47,972,495.28	409,860,165.71	72,704,192.29
RHODE ISLAND	26,246,642.00	524,325.83	19,738,992.84	6,507,649.16
SOUTH CAROLINA	81,091,486.00	4,643,282.99	61,969,303.20	19,122,182.80
SOUTH DAKOTA	41,315,041.92	5,584,349.54	33,570,941.47	7,744,100.45
TENNESSEE	277,324,539.00	18,356,244.60	236,415,642.00	40,908,897.00
TEXAS	781,488,831.00	15,886,360.82	722,813,095.55	58,534,936.00
UTAH	19,130,564.00	980,174.32	16,535,301.16	2,595,262.84
VERMONT	50,681,567.00	957,854.68	43,855,794.28	6,825,132.72
VIRGINIA	159,836,376.00	14,541,988.47	138,810,228.47	226,147.53
WASHINGTON	171,229,930.00	8,242,357.66	140,483,115.72	30,746,822.28
WEST VIRGINIA	157,714,908.00	13,740,690.76	125,883,480.30	31,831,567.70
WISCONSIN	171,129,298.00	16,582,410.44	149,774,121.16	21,355,176.84
WYOMING	19,781,638.45	1,417,366.00	16,012,249.00	3,769,389.45
DIST. OF COL.	57,207,891.00	5,793,598.50	40,788,692.94	16,419,198.06
PUERTO RICO	20,639,374.00	1,490,163.82	16,742,367.57	3,897,411.43
TOTAL	7,602,840,760.92	600,792,874.56	6,842,482,882.57	759,357,878.35

TABLE 1B

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

STATUS OF FUNDS PROVIDED FOR
BRIDGE REPLACEMENT & REHABILITATION MANDATORY 15% OFF-SYSTEM - 217

AS OF JUNE 30, 1988

STATE	TOTAL AVAILABLE	DURING FY 88	TOTAL TO DATE	UNOBLIGATED BALANCE
		OBLIGATIONS		
ALABAMA	33,540,684.00	3,842,765.53	29,517,829.08	4,022,858.92
ALASKA	4,414,743.00	384,000.00	2,784,223.41	1,630,519.59
ARIZONA	4,414,743.00	30,679.89	3,332,756.93	1,081,986.07
ARKANSAS	30,187,634.00	2,649,824.00	30,072,984.00	114,650.00
CALIFORNIA	48,937,841.00	5,861,000.33	48,938,937.01	903.99
COLORADO	16,577,076.00	1,789,025.85	14,273,964.26	2,303,111.74
CONNECTICUT	34,416,902.00	3,805,076.00	19,458,908.51	14,957,993.49
DELAWARE	4,414,743.00	12,775.30	3,810,597.06	604,145.94
FLORIDA	38,010,033.00	1,459,633.00	35,673,856.00	2,336,177.00
GEORGIA	42,457,385.00	3,381,422.78	35,843,270.64	6,614,108.36
HAWAII	4,966,706.00	5,772.82CR	2,582,481.53	2,384,224.47
IDAHO	6,896,552.00	192,297.53	6,563,933.28	332,618.72
ILLINOIS	80,560,898.00	2,814,760.40	76,867,870.18	3,693,027.82
INDIANA	83,357,613.00	1,994,647.10	81,350,780.22	2,006,832.78
IOWA	43,003,120.00	4,366,194.22	42,678,819.13	324,300.87
KANSAS	47,308,268.00	496,932.11	43,050,076.66	4,258,191.34
KENTUCKY	43,195,836.00	4,981,056.85	43,176,129.43	19,707.57
LOUISIANA	60,387,931.00	3,159,107.74	53,760,107.42	6,627,823.58
MAINE	9,010,593.00	581,120.53	8,748,116.49	262,476.51
MARYLAND	30,887,214.00	4,108,360.00	26,736,984.00	4,151,230.00
MASSACHUSETTS	43,823,603.00	2,279,103.13	19,709,109.11	24,112,493.89
MICHIGAN	25,633,752.00	2,794,163.29	25,147,821.88	485,930.12
MINNESOTA	32,880,264.00	65,746.92CR	32,551,342.03	328,921.97
MISSISSIPPI	31,704,948.00	2,199,621.00	26,975,479.00	4,729,469.00
MISSOURI	66,467,362.00	6,618,208.19	62,016,579.03	4,450,782.97
MONTANA	11,492,824.05	763,740.63	10,916,957.59	575,866.46
NEBRASKA	29,408,561.00	4,385,179.73	29,073,436.00	337,625.00
NEVADA	4,414,743.00	91,323.00	2,534,963.00	1,879,780.00
NEW HAMPSHIRE	12,971,690.00	1,421,549.52	12,831,044.07	140,645.93
NEW JERSEY	71,614,036.00	2,606,374.08	29,132,927.81	42,481,108.19
NEW MEXICO	6,540,467.00	210,218.84	6,047,025.84	493,441.16
NEW YORK	167,241,259.00	11,588,712.00	149,246,397.00	17,994,862.00
NORTH CAROLINA	52,053,438.00	4,941,292.00	45,925,374.00	6,128,064.00
NORTH DAKOTA	9,490,421.00	888,719.98	9,480,646.34	9,774.66
OHIO	53,199,137.00	7,288,665.00	51,280,816.00	1,918,321.00
OKLAHOMA	34,549,889.00	8,011,341.29	34,504,170.56	45,718.44
OREGON	16,807,725.00	2,419,362.67	16,416,415.48	391,309.52
PENNSYLVANIA	111,361,805.00	8,310,325.20	86,299,551.48	25,061,453.52
RHODE ISLAND	6,086,318.29	68,645.07CR	5,763,110.64	873,287.65
SOUTH CAROLINA	18,713,421.00	1,466,697.75	18,037,556.02	675,864.98
SOUTH DAKOTA	9,151,820.00	528,200.93	7,725,137.03	1,426,682.97
TENNESSEE	63,997,970.00	7,063,776.00	63,426,903.00	571,067.00
TEXAS	68,171,084.00	3,490,070.00	65,935,416.44	2,235,667.56
UTAH	4,414,743.00	130,390.76	3,807,535.00	607,208.00
VERMONT	11,695,746.00	348,154.92	10,615,468.48	1,080,277.52
VIRGINIA	36,700,700.00	6,850,355.59	35,017,989.74	1,682,710.26
WASHINGTON	39,514,601.00	701,438.18	33,425,819.57	6,089,581.43
WEST VIRGINIA	36,395,747.00	2,938,976.80	30,456,977.00	5,938,771.00
WISCONSIN	40,760,685.00	4,547,214.88	38,257,044.44	2,582,560.56
WYOMING	4,564,990.93	681,058.00	4,564,990.00	.93
DIST. OF COL.	1,051,617.00			1,051,617.00
PUERTO RICO	4,763,023.00	231,171.65	4,265,466.94	497,556.06
TOTAL	1,744,913,826.29	140,468,311.64	1,530,284,754.76	214,309,871.53

TABLE 1C

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

STATUS OF FUNDS PROVIDED FOR
BRIDGE REPLACEMENT & REHABILITATION MANDATORY 2CR ON/OFF-SYSTEM - 124

AS OF JUNE 30, 1988

STATE	TOTAL AVAILABLE	OBLIGATIONS DURING FY 88	OBLIGATIONS TOTAL TO DATE	UNOBLIGATED BALANCE
ALABAMA	44,720,908.00	3,894,214.39	42,529,354.13	2,191,553.87
ALASKA	5,886,325.00	1,040,661.00	4,794,740.00	1,091,585.00
ARIZONA	5,886,325.00	32,334.64CR	3,888,252.24	1,998,072.76
ARKANSAS	40,250,175.00	3,777,890.00	40,238,721.00	11,454.00
CALIFORNIA	65,249,389.00	7,693,493.35	65,081,658.05	167,730.95
COLORADO	22,102,762.00	493,295.50CR	13,559,525.31	8,543,236.69
CONNECTICUT	45,888,665.00	868,662.64	27,762,652.50	18,126,012.50
DELAWARE	5,886,325.00	212,136.70	4,041,370.94	1,844,954.06
FLORIDA	50,686,042.00	5,939,817.00	47,475,338.00	3,204,704.00
GEORGIA	56,609,840.00	1,352,713.34	49,466,434.89	7,143,405.11
HAWAII	6,638,274.00	330.00CR	5,934,914.48	687,359.52
IDAHO	9,145,400.00	719,489.87	9,154,088.13	29,331.87
ILLINOIS	107,334,529.00	9,993,986.28	107,191,499.35	143,029.65
INDIANA	44,476,811.00	3,637,447.65	35,130,026.44	9,346,784.56
IOWA	57,337,491.00	1,008,803.04	46,428,348.18	10,909,142.82
KANSAS	63,077,689.00	6,028,149.35	57,150,024.35	5,927,664.65
KENTUCKY	57,594,442.00	5,869,368.79	55,879,936.19	1,714,505.81
LOUISIANA	80,517,238.00	156,712.68	65,259,213.95	15,258,024.05
MAINE	13,014,119.00	384,989.35	12,269,951.79	744,167.21
MARYLAND	42,630,209.00	596,930.00	38,830,317.00	3,799,892.00
MASSACHUSETTS	58,428,801.00	2,370,780.89	51,911,462.88	6,517,338.12
MICHIGAN	34,178,333.00	4,296,744.16	30,442,197.22	3,736,135.78
MINNESOTA	48,040,349.00	6,710,113.45	43,732,758.82	4,307,590.18
MISSISSIPPI	42,273,290.00	2,817,992.00	39,743,963.00	2,529,293.00
MISSOURI	88,623,145.00	1,519,158.00	65,620,976.61	23,002,948.39
MONTANA	15,323,780.40	1,326,578.00	14,662,790.29	660,970.11
NEBRASKA	39,208,743.00	875,680.72	31,222,877.28	7,985,865.72
NEVADA	5,886,325.00	1,409,812.00	5,768,723.00	117,602.00
NEW HAMPSHIRE	17,295,581.00	1,592,104.88	17,094,790.07	200,790.93
NEW JERSEY	95,485,378.00	5,854,152.25	88,592,443.95	6,892,934.05
NEW MEXICO	8,720,618.00	93,919.64	4,143,699.61	4,576,918.39
NEW YORK	222,988,344.00	28,708,882.00	221,724,892.80	1,263,451.20
NORTH CAROLINA	69,404,579.00	5,346,283.00	61,657,793.00	7,746,786.00
NORTH DAKOTA	12,653,891.00	1,128,519.61	12,612,384.22	41,506.78
OHIO	70,932,178.00	987,534.00	38,059,208.00	32,876,970.00
OKLAHOMA	46,066,514.00	8,282,118.82	26,812,839.84	19,253,674.16
OREGON	22,410,297.00	2,866,084.00	18,641,279.34	3,769,021.66
PENNSYLVANIA*	148,481,335.00	247,215.76	98,738,108.42	49,743,226.58
RHODE ISLAND	7,930,707.90	48,400.00	5,235,554.51	2,695,243.39
SOUTH CAROLINA	24,951,223.00	586,731.62	19,839,416.57	5,111,806.43
SOUTH DAKOTA	12,202,420.00	669,930.32	10,039,019.29	2,163,400.71
TENNESSEE	85,330,625.00	5,391,201.00	80,540,810.00	4,789,815.00
TEXAS	84,894,779.00	2,447,561.98	67,407,334.64	17,487,444.36
UTAH	5,886,325.00	54,776.54	4,599,192.53	1,287,132.47
VERMONT	15,594,327.00	1,625,641.24	14,375,850.60	1,218,476.40
VIRGINIA	50,634,206.00	994,161.96	47,042,405.38	3,591,800.62
WASHINGTON	52,686,131.00	12,525,490.34	42,242,796.43	10,443,334.57
WEST VIRGINIA	48,527,660.00	275,134.00CR	36,207,064.00	12,320,596.00
WISCONSIN	54,347,472.00	2,399,368.29	39,345,192.21	15,002,279.79
WYOMING	6,028,655.60	601,829.00	5,812,247.00	274,408.60
DIST. OF COL.	29,752,629.00	1,966,394.83CR	20,116,538.03	9,636,090.97
PUERTO RICO	11,619,253.00	61,690.96	9,294,667.78	2,324,585.22
TOTAL	2,361,806,948.90	154,207,157.36	2,001,345,224.24	360,461,724.66

TABLE 1D

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

STATUS OF FUNDS PROVIDED FOR
BRIDGE REPLACEMENT DISCRETIONARY FUNDS - 119

AS OF JUNE 30, 1968

STATE	TOTAL AVAILABLE	OBLIGATIONS DURING FY 68	OBLIGATIONS TOTAL TO DATE	UNOBLIGATED BALANCE
ALABAMA	105,921,463.62	13,117,920.00	105,921,463.62	
ALASKA	20,369,305.26		20,369,305.26	
ARIZONA	4,698,019.17	1,821,980.83CR	4,698,019.17	
ARKANSAS				
CALIFORNIA	123,446,779.46	230,000.00	108,516,779.46	14,930,000.00
COLORADO	67,538,132.39		55,998,932.39	11,539,200.00
CONNECTICUT	21,855,000.00	21,855,000.00	21,855,000.00	
DELAWARE	13,798,433.61	13,829.09CR	13,798,433.61	
FLORIDA	25,888,432.00	8,888,000.00	25,888,432.00	
GEORGIA	29,480,000.00		29,480,000.00	
HAWAII	4,400,000.00	4,400,000.00	4,400,000.00	
IDAHO	24,069,649.00		24,069,649.00	
ILLINOIS	162,410,418.98	18,221,293.83	162,268,712.81	141,706.17
INDIANA				
IOWA	66,021,560.23	14,406,755.63	65,902,876.01	119,484.22
KANSAS	31,218,251.82		31,218,251.82	
KENTUCKY				
LOUISIANA	6,532,976.00		6,532,976.00	
MAINE	8,800,000.00		8,800,000.00	
MARYLAND	28,433,000.00		28,433,000.00	
MASSACHUSETTS	60,000.00		60,000.00	
MICHIGAN	32,806,120.00		32,806,120.00	
MINNESOTA	32,201,940.19		32,201,940.19	
MISSISSIPPI	57,283,819.00	50,374.00	56,234,191.00	1,049,624.00
MISSOURI	71,796,838.32	1,633,459.24	71,796,838.32	
MONTANA	2,736,000.00		2,736,000.00	
NEBRASKA	11,118,819.23		10,866,485.96	252,333.27
NEVADA	10,800,000.00			10,800,000.00
NEW HAMPSHIRE	19,733,650.49	252,283.41	9,989,934.40	9,747,716.09
NEW JERSEY	39,688,096.00		39,688,096.00	
NEW MEXICO				
NEW YORK	248,082,178.60	128,493.00CR	242,952,178.60	5,050,000.00
NORTH CAROLINA	8,387,680.00	603,332.00CR	8,387,680.00	
NORTH DAKOTA	11,975,296.56	824,703.44CR	11,975,296.56	
OHIO	40,365,648.00		40,017,970.00	347,678.00
OKLAHOMA				
OREGON	36,468,500.75	385,269.00CR	36,179,195.75	233,305.00
PENNSYLVANIA	154,409,590.51	19,944,867.51	154,409,590.51	
RHODE ISLAND	45,818,000.00		45,818,000.00	
SOUTH CAROLINA	128,599,721.39	94,637,243.82	120,693,896.21	7,905,825.18
SOUTH DAKOTA				
TENNESSEE	46,900,432.00	1,518,000.00	46,900,432.00	
TEXAS	8,400,000.00		8,400,000.00	
UTAH				
VERMONT	10,256,110.00	900,000.00CR	9,356,110.00	900,000.00
VIRGINIA	41,676,905.10	50,859.12CR	41,676,905.10	
WASHINGTON	72,714,126.50		72,714,126.50	
WEST VIRGINIA	47,062,000.00	1,962,248.00CR	45,099,752.00	1,962,248.00
WISCONSIN	97,153,797.44	361,492.80CR	97,153,797.44	
WYOMING				
DIST. OF COL.	15,868,000.00		15,868,000.00	
PUERTO RICO				
SUBTOTAL	1,996,454,486.32	149,412,296.16	1,831,475,365.89	64,979,120.43
UNALLOCATED	2,435,975.52			
TOTAL	1,998,890,461.84			

TABLE 2A

STATUS OF BRIDGES APPROVED FOR THE BRIDGE PROGRAMS
MANDATORY 65 PERCENT ON-SYSTEM - 118
AS OF JUNE 30, 1988

	BRIDGES BEING PREPARED FOR CONSTRUCTION	BRIDGES UNDER CONSTRUCTION	BRIDGES COMPLETE	TOTAL
ALABAMA	295	59	222	576
ALASKA	1	12	12	25
ARIZONA	2	0	18	20
ARKANSAS	55	64	259	378
CALIFORNIA	114	75	203	392
COLORADO	77	27	107	211
CONNECTICUT	33	35	54	122
DELAWARE	4	5	7	16
DIST. OF COL.	8	5	7	20
FLORIDA	41	20	71	132
GEORGIA	218	141	253	612
HAWAII	11	2	6	19
IDAHO	41	8	56	105
ILLINOIS	56	80	610	746
INDIANA	28	33	156	217
IOWA	130	63	496	683
KANSAS	164	102	272	538
KENTUCKY	99	90	195	384
LOUISIANA	96	28	208	332
MAINE	35	5	44	84
MARYLAND	8	32	73	113
MASSACHUSETTS	20	44	42	106
MICHIGAN	3	40	167	210
MINNESOTA	4	43	233	280
MISSISSIPPI	30	52	223	305
MISSOURI	119	57	272	448
MONTANA	60	48	41	149
NEBRASKA	49	68	331	448
NEVADA	5	6	23	34
NEW HAMPSHIRE	34	7	36	77
NEW JERSEY	125	42	39	206
NEW MEXICO	1	11	40	52
NEW YORK	283	105	317	705
NORTH CAROLINA	352	94	153	599
NORTH DAKOTA	5	27	120	152
OHIO	63	144	354	561
OKLAHOMA	79	62	60	201
OREGON	70	14	108	192
PENNSYLVANIA	249	86	163	498
RHODE ISLAND	17	3	8	28
SOUTH CAROLINA	35	29	71	135
SOUTH DAKOTA	39	45	89	173
TENNESSEE	95	76	539	710
TEXAS	23	92	285	400
UTAH	19	4	30	53
VERMONT	66	12	57	135
VIRGINIA	22	19	119	160
WASHINGTON	38	31	89	158
WEST VIRGINIA	80	41	87	208
WISCONSIN	244	62	323	629
WYOMING	0	10	44	54
PUERTO RICO	3	5	6	14
TOTAL	3,748	2,265	7,792	13,805

TABLE 2B

STATUS OF BRIDGES APPROVED FOR THE BRIDGE PROGRAMS
MANDATORY 15 PERCENT OFF-SYSTEM - 117
AS OF JUNE 30 1988

	BRIDGES BEING PREPARED FOR CONSTRUCTION	BRIDGES UNDER CONSTRUCTION	BRIDGES COMPLETE	TOTAL
ALABAMA	8	53	378	439
ALASKA	6	0	3	9
ARIZONA	1	1	24	26
ARKANSAS	19	24	108	151
CALIFORNIA	97	29	91	217
COLORADO	8	5	29	42
CONNECTICUT	5	11	13	29
DELAWARE	4	4	16	24
DIST. OF COL.	0	0	0	0
FLORIDA	44	22	53	119
GEORGIA	115	52	209	376
HAWAII	4	1	4	9
IDAHO	15	3	32	50
ILLINOIS	60	54	690	804
INDIANA	76	30	73	179
IOWA	2	70	339	411
KANSAS	1	53	220	274
KENTUCKY	44	53	78	175
LOUISIANA	96	23	281	400
MAINE	14	5	40	59
MARYLAND	20	10	41	71
MASSACHUSETTS	4	12	6	22
MICHIGAN	4	18	102	124
MINNESOTA	5	15	283	303
MISSISSIPPI	0	25	151	176
MISSOURI	229	81	206	516
MONTANA	29	5	41	75
NEBRASKA	68	33	168	269
NEVADA	3	1	11	15
NEW HAMPSHIRE	15	6	20	41
NEW JERSEY	84	6	7	97
NEW MEXICO	2	2	23	27
NEW YORK	158	27	124	309
NORTH CAROLINA	146	54	113	313
NORTH DAKOTA	0	17	68	85
OHIO	10	59	194	263
OKLAHOMA	9	43	70	122
OREGON	55	8	73	136
PENNSYLVANIA	108	56	101	265
RHODE ISLAND	6	1	8	15
SOUTH CAROLINA	28	13	61	102
SOUTH DAKOTA	27	23	49	99
TENNESSEE	80	59	150	289
TEXAS	41	51	228	320
UTAH	13	5	20	38
VERMONT	34	2	59	95
VIRGINIA	9	22	134	165
WASHINGTON	75	31	118	224
WEST VIRGINIA	27	15	49	91
WISCONSIN	162	68	267	497
WYOMING	18	6	14	38
PUERTO RICO	1	3	3	7
TOTAL	2,089	1,270	5,643	9,002

TABLE 2C

STATUS OF BRIDGES APPROVED FOR THE BRIDGE PROGRAMS
OPTIONAL 20 PERCENT ON/OFF-SYSTEM - 114
AS OF JUNE 30, 1988

	BRIDGES BEING PREPARED FOR CONSTRUCTION	BRIDGES UNDER CONSTRUCTION	BRIDGES COMPLETE	TOTAL
ALABAMA	73	32	131	236
ALASKA	4	0	4	8
ARIZONA	2	3	15	20
ARKANSAS	9	19	106	134
CALIFORNIA	42	42	81	165
COLORADO	18	2	17	37
CONNECTICUT	1	4	8	13
DELAWARE	3	1	2	6
DIST. OF COL.	9	0	4	13
FLORIDA	20	4	24	48
GEORGIA	22	67	94	183
HAWAII	1	0	0	1
IDAHO	6	4	22	32
ILLINOIS	15	32	348	395
INDIANA	35	19	51	105
IOWA	0	32	432	464
KANSAS	22	44	187	253
KENTUCKY	31	43	106	180
LOUISIANA	194	15	179	388
MAINE	5	5	30	40
MARYLAND	0	6	13	19
MASSACHUSETTS	16	12	9	37
MICHIGAN	6	17	121	144
MINNESOTA	6	18	127	151
MISSISSIPPI	4	36	141	181
MISSOURI	31	23	68	122
MONTANA	35	7	29	71
NEBRASKA	1	8	121	130
NEVADA	1	3	9	13
NEW HAMPSHIRE	13	3	33	49
NEW JERSEY	17	8	4	29
NEW MEXICO	0	1	10	11
NEW YORK	26	19	88	133
NORTH CAROLINA	169	52	80	301
NORTH DAKOTA	0	17	71	88
OHIO	0	12	82	94
OKLAHOMA	12	5	27	44
OREGON	16	7	58	81
PENNSYLVANIA	10	7	26	43
RHODE ISLAND	11	1	1	13
SOUTH CAROLINA	3	7	61	71
SOUTH DAKOTA	11	35	45	91
TENNESSEE	52	22	233	307
TEXAS	11	51	85	147
UTAH	2	0	16	18
VERMONT	28	5	37	70
VIRGINIA	12	3	63	78
WASHINGTON	13	15	18	46
WEST VIRGINIA	6	4	22	32
WISCONSIN	124	34	230	388
WYOMING	3	4	12	19
PUERTO RICO	1	2	3	6
TOTAL	1,152	812	3,784	5,748

TABLE 3

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM
DISCRETIONARY FUNDING STATUS REPORT
As Of August 25, 1980

STATE	BRIDGE	Allocations Approved (IN MILLIONS) FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988
Alabama	Cochrane	$ 0.608	$ 1.200	$ 1.520			$ 6.735	$30.102	$34.080		
	Claiborne-Murphy				$ 0.640	$ 6.929					
	Crumpton									$10.264	
	W.R. King										$13.443
Alaska	Gastineau and Kowee Creek	20.369									
Arizona	Little Colorado									4.658	
California	Golden Gate	1.000	2.549	15.300	26.012	10.200			4.305		
	San Mateo		0.720	4.000	1.649						
	Russian River at Preston					0.520	0.200	1.957	18.800		
	Mission Bay Channel							10.100			
	Fisherman's Channel									10.720	
	Potato Slough										15.160
Colorado	Colfax-Larimer Viaduct				6.080	13.628	13.290	17.301			
	Speer Blvd.									5.700	11.539

TABLE 3 (cont'd)

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM
DISCRETIONARY FUNDING STATUS REPORT
As Of August 25, 1988

STATE	BRIDGE	Allocations Approved (IN MILLIONS) FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988
Connecticut	Niantic										19.338
Delaware	Augustine Cutoff		6.007								
	US 113 over St. Jones River				7.792						
Dist. of Col.	Key Bridge				0.500	1.360		14.000			
Florida	Barron Collier		8.926								
	Port Orange									8.160	
	Acosta										12.300
Georgia	Torras Causeway		1.600		19.400						
	13th Street								8.480		
Hawaii	Wailoa										4.400
Idaho	Sandpoint	9.600									
	Bonners Ferry				8.173			0.527			
	Old Town								5.770		
Illinois	Miss. Rv. @ Quincy	0.400	0.800	1.360	7.100	26.200		0.508			
	US 36 @ Florence	0.804						2.500	21.358		
	Pekin	11.400		3.084							

TABLE 3 (cont'd)

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM
DISCRETIONARY FUNDING STATUS REPORT
As Of August 25, 1988

STATE	BRIDGE	Allocations Approved (IN MILLIONS) FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988
	Franklin St. Bridge					1.280			0.770	0.190	0.200
	LaSalle-Peru Bridge					10.380	27.656				
	Staley Viaduct						1.200		0.960	23.410	2.203
	N.L. King										15.960
owa/Wisc.	Eagle Point	5.600	23.535								
owa/Ill.	Keokuk	0.360	0.440	7.856		10.017		2.525			
Iowa/ Nebraska	Missouri River @ Sioux City	2.723	0.365								
Iowa	MacArthur Bridge					0.500		0.047	0.990	1.469	16.357
Kansas/Mo.	US 36/Mo. River	8.002	5.626	1.958	1.784						
Kansas	West Kansas Avenue					6.250	12.036				
Maine	Million Dollar	0.400		0.400				0.160	1.200		
	Wiscasset-Edgecomb		2.500	3.700		0.240					
Maryland	South River		17.309								
	US 50-301/Severn								11.200		
Massachusetts	Fore River	0.060									

TABLE 3 (cont'd)

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM
DISCRETIONARY FUNDING STATUS REPORT
As Of August 25, 1988

STATE	BRIDGE	Allocations Approved (IN MILLIONS) FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988
Michigan	Third Street		1.824		0.151		19.911				
	MacArthur Bridge				10.720						
Minnesota	High Bridge						1.724	1.563	14.799		
Mississippi	Natchez-Vidalia	1.680		8.000			13.157	22.400	3.481		1.100
	Escatawpa River						5.948				
	Fort Bayou Bridge					8.051					
Missouri	US 67	15.684	2.391						0.610		
	US 5A/Grand Glaize				6.185	0.794					
	ASB		8.620	0.478	3.262	10.177	5.500	3.300	0.348	2.025	
	West Penway									4.620	2.409
Montana	Warden					2.736					
Nebraska/Iowa	Nebraska City				0.565	8.015	1.355	1.040	0.830		.827
Nevada	Wells Avenue										12.080
New Hampshire	Notre Dame Bridge								7.300	2.434	10.000
New Jersey	Rte. 22WB/Waverly Yards				0.480	11.200					

TABLE 3 (cont'd)

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM
DISCRETIONARY FUNDING STATUS REPORT
As Of August 25, 1988

STATE	BRIDGE	Allocations Approved (IN MILLIONS) FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988
	Pulaski Skyway						15.200	0.108			
	Rt 40/in Thoro										
New York	South Park Avenue	7.543								12.700	
	Queensboro	1.335		18.588	28.125	8.800	0.496	37.664	7.080		
	Manhattan	2.152			5.464	0.736	27.832	2.800	0.720	10.800	
	Little Falls	3.050									
	Brooklyn					5.438	3.100		50.574		
	University Hghts									10.400	
	Father Baker										5.050
New York/VT	Rouses Point			0.400	1.016			18.196			
No th Carolina	US 421/Cape Fear				8.388						
North Dakota	Bismarck Memorial			1.850	10.125						
Ohio	Northfield Road Br.					5.490					
	North Main Street Viaduct	18.400	5.734								

TABLE 3 (cont'd)

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM
DISCRETIONARY FUNDING STATUS REPORT
As Of August 25, 1988

STATE	BRIDGE	Allocations Approved (IN MILLIONS) FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988
	Main Ave. Bridge						3.615				
	Hopple St. Viaduct							7.127			
Oregon	Center Street	0.720	0.320	15.135							
	Alsea Bay									20.000	
Pennsylvania	Bloomfield	2.880	6.640	8.640		1.840	5.800				
	Rochester-Monaca				2.400			14.000			
	Passyunk Avenue	30.000									
	Minsi Trail				8.880		4.000				
	Beaver Falls		0.800	9.795							
	Monongahela River					0.400	0.900	12.800			
	Towanda					1.000	7.490				
	Walnut Street									20.040	
	Girard & Belmont										16.100
Rhod Island	Jamestown	0.080	2.938		0.400	0.400	40.000			2.000	
South Carolina	Hilton Head, Skull & Mackey Creek	2.500	12.591								
	Sampit River		1.000	11.040					0.200		

TABLE 3 (cont'd)

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM
DISCRETIONARY FUNDING STATUS REPORT
As Of August 25, 1988

STATE	BRIDGE	Allocations Approved (IN MILLIONS) FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988
	James Island			4.400	1.760				12.000	21.170	61.939
Tennessee	Sidney Lewis Bridge					11.400					
	Walnut Street				14.028						
	Alvin York Bridge						0.575	9.280			
	Kernes (SR115)									10.190	1.518
Texas	Brazos Rv. Div Channel		8.400								
Virginia	James River	8.300	16.000	0.024							
	Hampmond River	3.353									
	Robert E. Lee Bridge					2.000					
	Williams Viaduct								12.000		
Washington	Swinomish Channel	8.190	2.087	0.708							
	Pasco-Kennewick	1.729									
	West Seattle			60.000							
West Virginia/ Ohio	Weirton/ Steubenville				8.000	18.062	16.500		0.500		
	Old Mill-Marietta									4.000	

TABLE 3 (cont'd)

HIGHWAY BRIDGE REPLACEMENT AND REHABILITATION PROGRAM
DISCRETIONARY FUNDING STATUS REPORT
As Of August 25, 1988

STATE	BRIDGE	Allocations Approved (IN MILLIONS) FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988
Wisconsin/ Minnesota	Arrowhead	13.320	31.820	7.868	1.587	2.300	0.492				
Wisconsin/ Minnesota	Wabasha Bridge	———	———	———	———	———	———	———	3.520	5.732	———
	TOTAL	$182.242	$172.824	$186.104	$190.666	$186.343	$234.712	$210.005	$221.875	$190.582	$221.923

TABLE 4A

COUNT OF DEFICIENT BRIDGES BY STATE ON FEDERAL-AID SYSTEM AS OF JUNE 30, 1988

	BRIDGES IN INVENTORY	NON-DEFICIENT BRIDGES	STRUCTURALLY DEFICIENT	FUNCTIONALLY OBSOLETE	DEFICIENT BRIDGES
ALABAMA	7,741	4,664	1,008	2,069	3,077
ALASKA	578	531	38	9	47
ARIZONA	4,526	4,255	72	199	271
ARKANSAS	5,952	4,257	335	1,360	1,695
CALIFORNIA	14,836	12,686	522	1,628	2,150
COLORADO	3,570	2,964	454	152	606
CONNECTICUT	2,602	902	640	1,060	1,700
DELAWARE	475	401	47	27	74
DIST. OF COL.	210	164	45	1	46
FLORIDA	6,111	5,080	128	903	1,031
GEORGIA	8,053	5,189	858	2,006	2,864
HAWAII	664	509	84	71	155
IDAHO	1,674	1,443	158	73	231
ILLINOIS	10,666	8,486	1,694	486	2,180
INDIANA	7,272	4,971	733	1,568	2,301
IOWA	7,192	5,277	741	1,174	1,915
KANSAS	10,774	7,567	795	2,412	3,207
KENTUCKY	4,953	2,762	234	1,957	2,191
LOUISIANA	5,976	4,193	861	922	1,783
MAINE	1,278	1,066	145	67	212
MARYLAND	2,786	1,721	443	622	1,065
MASSACHUSETTS	3,758	2,547	1,078	133	1,211
MICHIGAN	5,855	4,644	963	248	1,211
MINNESOTA	5,148	4,293	535	320	855
MISSISSIPPI	7,527	4,367	1,462	1,698	3,160
MISSOURI	8,863	5,463	1,934	1,466	3,400
MONTANA	2,440	1,128	91	1,221	1,312
NEBRASKA	5,100	3,760	805	535	1,340
NEVADA	802	714	16	72	88
NEW HAMPSHIRE	1,242	952	162	128	290
NEW JERSEY	4,218	2,919	901	398	1,299
NEW MEXICO	2,734	2,256	258	220	478
NEW YORK	8,817	3,456	4,770	591	5,361
NORTH CAROLINA	5,556	3,867	232	1,457	1,689
NORTH DAKOTA	1,782	1,095	158	529	687
OHIO	12,271	10,076	2,038	157	2,195
OKLAHOMA	8,511	5,301	1,214	1,996	3,210
OREGON	3,752	3,323	246	183	429
PENNSYLVANIA	10,848	7,062	2,674	1,112	3,786
RHODE ISLAND	566	473	71	22	93
SOUTH CAROLINA	4,237	3,447	232	558	790
SOUTH DAKOTA	2,751	2,293	253	205	458
TENNESSEE	7,498	4,965	1,137	1,396	2,533
TEXAS	26,076	21,318	1,315	3,443	4,758
UTAH	1,572	1,475	71	26	97
VERMONT	1,299	858	163	278	441
VIRGINIA	6,850	5,239	804	807	1,611
WASHINGTON	4,034	2,817	636	581	1,217
WEST VIRGINIA	3,328	1,680	1,165	483	1,648
WISCONSIN	6,351	4,172	1,738	441	2,179
WYOMING	1,902	1,762	51	89	140
PUERTO RICO	1,006	581	92	333	425
TOTAL	274,583	197,391	37,300	39,892	77,192

TABLE 4B

COUNT OF DEFICIENT BRIDGES BY STATE
OFF FEDERAL-AID SYSTEM
AS OF JUNE 30, 1988

	BRIDGES IN INVENTORY	NON-DEFICIENT BRIDGES	STRUCTURALLY DEFICIENT	FUNCTIONALLY OBSOLETE	DEFICIENT BRIDGES
ALABAMA	7,793	3,319	2,941	1,533	4,474
ALASKA	222	158	48	16	64
ARIZONA	1,097	956	88	53	141
ARKANSAS	7,065	2,939	1,261	2,865	4,126
CALIFORNIA	7,425	3,854	1,144	2,427	3,571
COLORADO	3,858	1,796	1,754	308	2,062
CONNECTICUT	1,147	446	321	380	701
DELAWARE	263	162	32	69	101
DIST. OF COL.	27	24	3	0	3
FLORIDA	4,077	2,893	482	702	1,184
GEORGIA	6,173	2,999	2,662	512	3,174
HAWAII	379	258	31	90	121
IDAHO	2,071	1,228	402	441	843
ILLINOIS	14,762	9,587	3,619	1,556	5,175
INDIANA	10,245	4,890	3,874	2,281	5,355
IOWA	18,673	8,212	5,299	5,162	10,461
KANSAS	14,874	5,348	4,591	4,935	9,526
KENTUCKY	7,638	2,370	1,973	3,295	5,268
LOUISIANA	8,163	3,544	3,898	1,521	4,619
MAINE	1,305	750	291	264	555
MARYLAND	1,788	981	260	547	807
MASSACHUSETTS	1,206	494	636	76	712
MICHIGAN	4,726	2,626	1,665	435	2,100
MINNESOTA	7,846	5,003	1,376	1,467	2,843
MISSISSIPPI	9,467	3,643	4,959	865	5,824
MISSOURI	14,819	3,154	10,413	1,252	11,665
MONTANA	2,192	769	404	1,019	1,423
NEBRASKA	10,743	3,289	6,831	623	7,454
NEVADA	271	200	34	37	71
NEW HAMPSHIRE	1,330	495	360	475	835
NEW JERSEY	1,779	974	451	354	805
NEW MEXICO	705	439	152	114	266
NEW YORK	8,509	2,058	5,639	812	6,451
NORTH CAROLINA	10,599	3,799	875	5,925	6,800
NORTH DAKOTA	3,501	1,147	1,801	553	2,354
OHIO	16,909	13,106	2,456	1,347	3,803
OKLAHOMA	14,470	4,774	7,015	2,681	9,696
OREGON	2,856	2,150	331	375	706
PENNSYLVANIA	11,609	6,488	3,316	1,805	5,121
RHODE ISLAND	136	93	27	16	43
SOUTH CAROLINA	4,649	3,664	707	278	985
SOUTH DAKOTA	4,071	1,339	1,407	1,325	2,732
TENNESSEE	11,048	6,192	3,229	1,627	4,856
TEXAS	18,238	7,843	5,257	5,138	10,395
UTAH	971	710	191	70	261
VERMONT	1,366	496	340	530	870
VIRGINIA	5,802	3,129	803	1,870	2,673
WASHINGTON	2,864	2,220	284	360	644
WEST VIRGINIA	3,185	842	1,630	713	2,343
WISCONSIN	6,612	3,358	2,248	1,014	3,254
WYOMING	924	388	269	267	536
PUERTO RICO	679	366	54	259	313
TOTAL	303,127	141,962	98,526	62,639	161,165

TABLE 5A

COUNT OF OPEN, CLOSED AND POSTED BRIDGES ON FEDERAL-AID SYSTEM AS OF JUNE 30, 1988

	BRIDGES IN INVENTORY	OPEN - NOT REQUIRING LOAD POSTING	CLOSED BRIDGES	POSTED BRIDGES	OPEN - SHOULD BE POSTED BUT ARE NOT POSTED
ALABAMA	7,741	6,427	24	974	316
ALASKA	578	539	1	37	1
ARIZONA	4,526	4,491	3	27	5
ARKANSAS	5,952	5,214	8	669	61
CALIFORNIA	14,836	14,745	18	78	3
COLORADO	3,570	3,475	6	88	1
CONNECTICUT	2,602	2,476	18	99	9
DELAWARE	475	436	1	30	8
DIST. OF COL.	210	167	2	41	0
FLORIDA	6,111	5,538	12	539	22
GEORGIA	8,053	7,350	10	661	32
HAWAII	664	609	0	54	1
IDAHO	1,674	1,482	0	192	0
ILLINOIS	10,666	10,152	4	270	240
INDIANA	7,272	6,647	15	593	17
IOWA	7,192	6,532	9	633	18
KANSAS	10,774	8,038	21	2,672	43
KENTUCKY	4,953	4,575	2	249	127
LOUISIANA	5,976	5,274	23	631	48
MAINE	1,278	1,246	1	28	3
MARYLAND	2,786	2,623	1	47	115
MASSACHUSETTS	3,758	3,163	68	491	36
MICHIGAN	5,855	5,318	116	403	18
MINNESOTA	5,148	4,968	3	165	12
MISSISSIPPI	7,527	5,128	39	2,332	28
MISSOURI	8,863	6,483	6	2,328	46
MONTANA	2,440	2,364	0	40	36
NEBRASKA	5,100	4,289	6	799	6
NEVADA	802	797	0	4	1
NEW HAMPSHIRE	1,242	1,197	8	22	15
NEW JERSEY	4,218	3,786	20	397	15
NEW MEXICO	2,734	2,706	1	26	1
NEW YORK	8,817	8,599	30	188	0
NORTH CAROLINA	5,556	4,719	7	827	3
NORTH DAKOTA	1,782	1,571	0	148	63
OHIO	12,271	11,575	37	498	161
OKLAHOMA	8,511	7,712	19	471	309
OREGON	3,752	3,625	4	107	16
PENNSYLVANIA	10,848	10,176	25	644	3
RHODE ISLAND	566	535	2	23	6
SOUTH CAROLINA	4,237	4,120	3	92	22
SOUTH DAKOTA	2,751	2,413	1	324	13
TENNESSEE	7,498	7,288	7	155	48
TEXAS	26,076	25,402	3	422	249
UTAH	1,572	1,498	2	39	33
VERMONT	1,299	1,270	0	29	0
VIRGINIA	6,850	6,370	8	472	0
WASHINGTON	4,034	3,967	2	59	6
WEST VIRGINIA	3,328	2,915	5	385	23
WISCONSIN	6,351	6,263	0	70	18
WYOMING	1,902	1,871	1	21	9
PUERTO RICO	1,006	979	4	22	1
TOTAL	274,583	251,103	606	20,607	2,267

TABLE 5B

COUNT OF OPEN, CLOSED AND POSTED BRIDGES
OFF FEDERAL-AID SYSTEM
AS OF JUNE 30, 1988

	BRIDGES IN INVENTORY	OPEN - NOT REQUIRING LOAD POSTING	CLOSED BRIDGES	POSTED BRIDGES	OPEN - SHOULD BE POSTED BUT ARE NOT POSTED
ALABAMA	7,793	3,580	35	3,201	977
ALASKA	222	106	6	84	26
ARIZONA	1,097	911	10	153	23
ARKANSAS	7,065	3,246	16	3,217	586
CALIFORNIA	7,425	6,778	26	585	44
COLORADO	3,858	2,058	26	1,714	60
CONNECTICUT	1,147	950	30	164	3
DELAWARE	263	206	3	53	1
DIST. OF COL.	27	12	1	14	0
FLORIDA	4,877	2,351	50	1,554	122
GEORGIA	6,173	3,163	171	2,575	264
HAWAII	379	287	0	83	9
IDAHO	2,071	1,498	6	567	0
ILLINOIS	14,762	10,706	289	3,029	738
INDIANA	10,245	5,369	230	4,499	147
IOWA	18,673	10,008	217	8,408	40
KANSAS	14,874	6,160	241	8,388	85
KENTUCKY	7,638	4,795	194	1,749	900
LOUISIANA	8,163	3,646	68	3,292	1,157
MAINE	1,305	1,082	18	178	27
MARYLAND	1,788	1,141	8	239	400
MASSACHUSETTS	1,206	671	81	447	7
MICHIGAN	4,726	2,740	340	1,627	19
MINNESOTA	7,846	6,342	59	1,382	63
MISSISSIPPI	9,467	3,451	363	5,579	74
MISSOURI	14,819	3,608	689	10,403	119
MONTANA	2,192	1,121	11	768	292
NEBRASKA	10,743	3,013	118	7,572	40
NEVADA	271	241	5	21	4
NEW HAMPSHIRE	1,330	690	31	369	240
NEW JERSEY	1,779	1,108	38	604	29
NEW MEXICO	705	576	5	124	0
NEW YORK	8,509	6,701	163	1,645	0
NORTH CAROLINA	10,599	4,127	28	6,441	3
NORTH DAKOTA	3,501	1,441	33	1,816	211
OHIO	16,909	10,641	114	5,322	832
OKLAHOMA	14,470	6,392	205	6,157	1,716
OREGON	2,856	2,450	7	362	37
PENNSYLVANIA	11,609	7,667	227	3,706	9
RHODE ISLAND	136	100	6	29	1
SOUTH CAROLINA	4,649	3,887	41	532	189
SOUTH DAKOTA	4,071	1,697	21	2,279	74
TENNESSEE	11,048	8,318	77	1,992	661
TEXAS	18,238	9,131	105	2,293	6,709
UTAH	971	615	22	285	49
VERMONT	1,366	915	17	434	0
VIRGINIA	5,802	3,561	8	2,228	5
WASHINGTON	2,864	2,572	30	252	10
WEST VIRGINIA	3,185	1,821	39	1,259	66
WISCONSIN	6,612	5,389	37	1,182	4
WYOMING	924	401	8	463	52
PUERTO RICO	679	659	7	12	1
TOTAL	303,127	170,091	4,580	111,331	17,125

PART II

APPENDIX A

APPENDIX A

CODE OF FEDERAL REGULATIONS

23 HIGHWAYS - PART 650

Subpart D—Highway Bridge Replacement and Rehabilitation Program

§ 650.401 Purpose.

The purpose of this regulation is to prescribe policies and outline procedures for administering the Highway Bridge Replacement and Rehabilitation Program in accordance with 23 U.S.C. 144.

§ 650.403 Definitions of terms.

(a) *Bridge.* A structure, including supports, erected over a depression or an obstruction, such as water, a highway, or a railway, having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercoping of abutments or spring lines of arches, or extreme ends of the openings for multiple boxes; it may include multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening.

(b) *Sufficiency rating.* The numerical rating of a bridge based on its structural adequacy and safety, essentiality for public use, and its serviceability and functional obsolescence.

(c) *Rehabilitation.* The major work required to restore the structural integrity of a bridge as well as work necessary to correct major safety defects.

§ 650.405 Eligible projects.

(a) *General.* Deficient highway bridges on all public roads may be eligible for replacement or rehabilitation.

(b) *Types of projects which are eligible.* The following types of work are eligible for participation in the Highway Bridge Replacement and Rehabilitation Program (HBRRP), hereinafter known as the bridge program.

(1) *Replacement.* Total replacement of a structurally deficient or functionally obsolete bridge with a new facility constructed in the same general traffic corridor. A nominal amount of approach work, sufficient to connect the new facility to the existing roadway or to return the gradeline to an attainable touchdown point in accordance with good design practice is also eligible. The replacement structure must meet the current geometric, construction and structural standards required for the types and volume of projected traffic on the facility over its design life.

(2) *Rehabilitation.* The project requirements necessary to perform the major work required to restore the structural integrity of a bridge as well as work necessary to correct major safety defects are eligible except as noted under ineligible work. Bridges to be rehabilitated both on or off the F-A System shall, as a minimum, conform with the provisions of 23 CFR Part 625, Design Standards for Federal-aid Highways, for the class of highway on which the bridge is a part.

(c) *Ineligible work.* Except as otherwise prescribed by the Administrator, the costs of long approach fills, causeways, connecting roadways, interchanges, ramps, and other extensive earth structures, when constructed beyond the attainable touchdown point, are not eligible under the bridge program.

§ 650.407 Application for bridge replacement or rehabilitation.

(a) Agencies participate in the bridge program by conducting bridge inspections and submitting Structure Inventory and Appraisal (SI&A) sheet inspection data. Federal and local governments supply SI&A sheet data to the State agency for review and processing. The State is responsible for submitting the six computer card format or tapes containing all public road SI&A sheet bridge information through the Division Administrator of the Federal Highway Administration (FHWA) for processing. These requirements are prescribed in 23 CFR 650.309 and 650.311, the National Bridge Inspection Standards.

(b) Inventory data may be submitted as available and shall be submitted at such additional times as the FHWA may request.

(c) Inventory data on bridges that have been strengthened or repaired to eliminate deficiencies, or those that have been replaced or rehabilitated using bridge replacement and/or other funds, must be revised in the inventory through data submission.

(d) The Secretary may, at the request of a State, inventory bridges, on and off the Federal-aid system, for historic significance.

§ 650.409 Evaluation of bridge inventory.

(a) *Sufficiency rating of bridges.* Upon receipt and evaluation of the bridge inventory, a sufficiency rating will be assigned to each bridge by the Secretary in accordance with the approved AASHTO sufficiency rating formula. The sufficiency rating will be used as a basis for establishing eligibility and priority for replacement or rehabilitation of bridges; in general the lower the rating, the higher the priority.

(b) *Selection of bridges for inclusion in State program.* After evaluation of the inventory and assignment of sufficiency ratings, the Secretary will provide the State with a selection list of bridges within the State that are eligible for the bridge program. From that list or from previously furnished selection lists, the State may select bridge projects.

§ 650.411 Procedures for bridge replacement and rehabilitation projects.

(a) Consideration shall be given to projects which will remove from service highway bridges most in danger of failure.

(b) *Submission and approval of projects.* (1) Bridge replacement or rehabilitation projects shall be submitted by the State to the Secretary in accordance with 23 CFR Part 630 Subpart A Federal-Aid Programs, Approval and Authorization.

(2) Funds apportioned to a State shall be made available throughout each State on a fair and equitable basis.

(c)(1) Each approved project will be designed, constructed, and inspected for acceptance in the same manner as other projects on the system on which the project is located. It shall be the responsibility of the State agency to properly maintain, or cause to be properly maintained, any project constructed under this bridge program. The State highway agency shall enter into a formal agreement for maintenance with appropriate local government officials in cases where an eligible project is located within and is under the legal authority of such a local government.

(2) Whenever a deficient bridge is replaced or its deficiency alleviated by a new bridge under the bridge program, the deficient bridge shall either be dismantled or demolished or its use limited to the type and volume of traffic the structure can safely service over its remaining life. For example, if the only deficiency of the existing structure is inadequate roadway width and the combination of the new and existing structure can be made to meet current standards for the volume of traffic the facility will carry over its design life, the existing bridge may remain in place and be incorporporated into the system.

§ 650.413 Funding.

(a) Funds authorized for carrying out the Highway Bridge Replacement and Rehabilitation Program are available for obligation at the beginning of the fiscal year for which authorized and remain available for expenditure for the same period as funds apportioned for projects on the Federal-aid primary system.

(b) The Federal share payable on account of any project carried out under 23 U.S.C. 144 shall be 80 percent of the eligible cost.

(c) Not less than 15 percent nor more than 35 percent of the apportioned funds shall be expended for projects located on public roads, other than those on a Federal-aid system. The Secretary after consultation with State and local officials may, with respect to a State, reduce the requirement for expenditure for bridges not on a Federal-aid system when he determines that such State has inadequate needs to justify such expenditure.

§ 650.415 Reports.

The Secretary must report annually to the Congress on projects approved and current inventories together with recommendations for further improvements.

Effective Date:
December 13, 1979

PART II

APPENDIX B

APPENDIX B

Federal Register / Vol. 48, No. 223 / Thursday, November 17, 1983 / Rules and Regulations

DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

23 CFR Part 650

Bridges, Structures, and Hydraulics; Discretionary Bridge Criteria

AGENCY: Federal Highway Administration (FHWA), DOT.

ACTION: Final rule.

Subpart G—Discretionary Bridge Candidate Rating Factor

Sec.

650.701 Purpose.
650.703 Eligible projects for discretionary bridge funds.
650.705 Application for discretionary bridge funds.
650.707 Rating factor.
650.709 Special considerations.

Authority: 101, Pub. L. 97-424, 96 Stat. 2097; 23 U.S.C. 144, 315; 49 CFR 1.48(b).

Subpart G—Discretionary Bridge Candidate Rating Factor

§ 650.701 Purpose.

The purpose of this regulation is to describe a rating factor used as part of a selection process of allocation of discretionary bridge funds made available to the Secretary of Transportation under 23 U.S.C. 144.

§ 650.703 Eligible projects.

(a) Deficient highway bridges on Federal-aid highway system roads may be eligible for allocation of discretionary bridge funds to the same extent as they are for bridge funds apportioned under 23 U.S.C. 144, provided that the total project cost for a discretionary bridge candidate is at least $10 million or twice the amount of 23 U.S.C. 144 funds apportioned to the State during the fiscal year for which funding for the candidate bridge is requested.

(b) After the effective date of this regulation for the discretionary bridge candidate rating factor, only candidate bridges not previously selected with a computed rating factor of 100 or less will be eligible for consideration.

§ 650.705 Application for discretionary bridge funds.

Each year through its field offices, the FHWA will issue an annual call for discretionary bridge candidate submittals including updates of previously submitted but not selected projects. Each State is responsible for submitting such data as required for candidate bridges. Data requested will include structure number, funds needed by fiscal year, total project cost, current average daily truck traffic and a narrative describing the existing bridge, the proposed new or rehabilitated bridge and other relevant factors which the State believes may warrant special consideration.

§ 650.707 Rating factor.

(a) The following formula is to be used in the selection process for ranking discretionary bridge candidates:

$$\text{Rating Factor (RF)} = \frac{SR}{D} \times \frac{TPC}{ADT'} \times A$$

$$A = \left[1 + \frac{\text{Unobligated HBRRP Balance}}{\text{Total HBRRP Funds Received}}\right]$$

The lower the rating factor, the higher the priority for selection and funding.

(b) The terms in the rating factor are defined as follows:

SR is Sufficiency Rating computed as illustrated in Appendix A of the Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, USDOT/FHWA (latest edition); (If SR is less than 1.0, use SR = 1.0);

ADT is Average Daily Traffic in thousands taking the most current value from the national bridge inventory data;

ADTT is Average Daily Truck Traffic in thousands (Pick up trucks and light delivery trucks not included);

For load posted bridges, the ADTT furnished should be that which would use the bridge if traffic were not restricted.

The ADTT should be the annual average volume, not peak or seasonal.

D is Defense Highway System Status
D = 1 if not on defense highway
D = 1.8 if bridge carries a designated defense highway

The last term of the rating factor expression includes the State's unobligated balance of funds received under 23 U.S.C. 144 as of June 30 preceding the date of calculation, and the total funds received under 23 U.S.C. 144 for the last four fiscal years ending with the most recent fiscal year of the FHWA's annual call for discretionary bridge candidate submittals; (If unobligated HBRRP balance is less than $10 million, use zero balance);

TPC is Total Project Cost in millions of dollars;
HBRRP is Highway Bridge Replacement and Rehabilitation Program;
ADT' is ADT plus ADTT.

(c) In order to balance the relative importance of candidate bridges with very low (less than one) sufficiency ratings and very low ADT's against candidate bridges with high ADT's, the minimum sufficiency rating used will be 1.0. If the computed sufficiency rating for a candidate bridge is less than 1.0, use 1.0 in the rating factor formula.

(d) If the unobligated balance of HBRRP funds for the State is less than $10 million, the HBRRP modifier is 1.0. This will limit the effect of the modifier on those States with small apportionments or those who may be accumulating funds to finance a major bridge.

§ 650.709 Special considerations.

(a) The selection process for new discretionary bridge projects will be based upon the rating factor priority ranking. However, although not specifically included in the rating factor formula, special consideration will be given to bridges that are closed to all traffic or that have a load restriction of less than 10 tons. Consideration will also be given to bridges with other unique situations, and to bridge candidates in States which have not previously been allocated discretionary bridge funds.

(b) The need to administer the program from a balanced national perspective requires that the special cases set forth in paragraph (a) of this section and other unique situations be considered in the discretionary bridge candidate evaluation process.

(c) Priority consideration will be given to the continuation and completion of bridge projects previously begun with discretionary bridge funds.

PART II

APPENDIX C

Appendix C

National Bridge Inspection Standards

CODE OF FEDERAL REGULATIONS

23 HIGHWAYS - PART 650

Subpart C - National Bridge Inspection Standards

§650.301 Application of standards.

The National Bridge Inspection Standards in this part apply to all structures defined as bridges located on all public roads. In accordance with the AASHTO (American Association of State Highway and Transportation Officials) Transportation Glossary, a "bridge" is defined as a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

§650.303 Inspection procedures.

(a) Each highway department shall include a bridge inspection organization capable of performing inspections, preparing reports, and determining ratings in accordance with the provisions of the AASHTO Manual[1] and the Standards contained herein.

(b) Bridge inspectors shall meet the minimum qualifications stated in §650.307.

(c) Each structure required to be inspected under the Standards shall be rated as to its safe load carrying capacity in accordance with Section 4 of the AASHTO Manual. If it is determined under this rating procedure that the maximum legal load under State law exceeds the load permitted under the Operating Rating, the bridge must be posted in conformity with the AASHTO Manual or in accordance with State law.

(d) Inspection records and bridge inventories shall be prepared and maintained in accordance with the Standards.

(e) The individual in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting and inventory shall determine and designate on the individual inspection and inventory records and maintain a master list of the following:

(1) Those bridges which contain fracture critical members, the location and description of such members on the bridge and the inspection frequency and procedures for inspection of such members. (Fracture critical members are tension members of a bridge whose failure will probably cause a portion of or the entire bridge to collapse.)

(2) Those bridges with underwater members which cannot be visually evaluated during periods of low flow or examined by feel for condition, integrity and safe load capacity due to excessive water depth or turbidity. These members shall be described, the inspection frequency stated, not to exceed five years, and the inspection procedure specified.

(3) Those bridges which contain unique or special features requiring additional attention during inspection to ensure the safety of such bridges and the inspection frequency and procedure for inspection of each such feature.

(4) The date of last inspection of the features designated in paragraphs (e)(1) through (e)(3) of this section and a description of the findings and follow-up actions, if necessary, resulting from the most recent inspection of fracture critical details, underwater members or special features of each so designated bridge.

§650.305 Frequency of inspections.

(a) Each bridge is to be inspected at regular intervals not to exceed 2 years in accordance with Section 2.3 of the AASHTO Manual.

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[1] *The "AASHTO Manual" referred to in this part is the "Manual for Maintenance Inspection of Bridges 1983" together with subsequent interim changes or the most recent version of the AASHTO manual published by the American Association of State Highway and Transportation Officials. A copy of the Manual may be examined during normal business hours at the office of each Division Administrator of the Federal Highway Administration, at the office of each Regional Federal Highway Administrator, and at the Washington Headquarters of the Federal Highway Administration. The addresses of those document inspection facilities are set forth in Appendix D to Part 7 of the regulations of the Office of the Secretary (40 CFR Part 7). In addition, a copy of the Manual may be secured upon payment in advance by writing to the American Association of State Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 225, Washington, D.C. 20001.*

(b) Certain types or groups of bridges will require inspection at less than 2-year intervals. The depth and frequency to which bridges are to be inspected will depend on such factors as age, traffic characteristics, state of maintenance, and known deficiencies. The evaluation of these factors will be the responsibility of the individual in charge of the inspection program.

(c) The maximum inspection interval may be increased for certain types or groups of bridges where past inspection reports and favorable experience and analysis justifies the increased interval of inspection. If a State proposes to inspect some bridges at greater than the specified 2-year interval, the State shall submit a detailed proposal and supporting data to the Federal Highway Administrator for approval.

§650.307 Qualifications of personnel.

(a) The individual in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting, and inventory shall possess the following minimum qualifications:

(1) Be a registered professional engineer; or

(2) Be qualified for registration as a professional engineer under the laws of the State; or

(3) Have a minimum of 10 years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the, "Bridge Inspector's Training Manual"[2], which has been developed by a joint Federal-State task force, and subsequent additions to the manual.[3]

(b) An individual in charge of a bridge inspection team shall possess the following minimum qualifications:

(1) Have the qualifications specified in paragraph (a) of this section; or

(2) Have a minimum of 5 years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the "Bridge Inspector's Training Manual", which has been developed by a joint Federal-State task force.

(3) Current certification as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies (NICET)[4] is an alternative acceptable means for establishing that a bridge inspection team leader is qualified.

§650.309 Inspection report.

The findings and results of bridge inspections shall be recorded on standard forms. The data required to complete the forms and the functions which must be performed to compile the data are contained in Section 3 of the AASHTO Manual.

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[2]The "Bridge Inspector's Training Manual" may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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[3]The following publications are supplements to the "Bridge Inspector's Training Manual": "Bridge Inspector's Manual for Movable Bridges," 1977, GPO Stock No. 050-002-00103-5; "Culvert Inspector's Training Manual," July 1986, GPO Stock No. 050-001-0030-7; and "Inspection of Fracture Critical Bridge Members," 1986, GPO Stock No. 050-001-00302-3.

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§650.311 Inventory.

(a) Each State shall prepare and maintain an inventory of all bridge structures subject to the Standards. Under these Standards, certain structure inventory and appraisal data must be collected and retained within the various departments of the State organization for collection by the Federal Highway Administration as needed. A tabulation of this data is contained in the structure inventory and appraisal sheet distributed by the Federal Highway Administration as part of the Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (Coding Guide) in January of 1979. Reporting procedures have been developed by the Federal Highway Administration.

(b) Newly completed structures, modification of existing structures which would alter previously recorded data on the inventory forms or placement of load restriction signs on the approaches to or at the structure itself shall be entered in the State's inspection reports and the computer inventory file as promptly as practical, but no later than 90 days after the change in the status of the structure for bridges directly under the State's jurisdiction and no later than 180 days after the change in status of the structure for all other bridges on public roads within the State.

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[4]For information on NICET program certification contact: National Institute for Certification in Engineering Technologies, 1420 King Street, Alexandria, Virginia 22314. Attention: John D. Antrim, P.E., Phone (703) 684-2835.

Effective date October 25, 1988.